Agriculture

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AGRICULTURE

THE JOURNAL OF THE MINISTRY OF AGRICULTURE

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Cover Photograph

Shattered sea-wall at Mablethorpe, Lincolnshire

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Speech of the Prime Minister, the Rt. Hon. Winston Churchill, O.M., C.H., D.L., M.P., at the Annual Dinner of the National Farmers' Union on February 17, 1953.

MR. PRESIDENT, Your Excellencies, My Lords, Ladies and Gentlemen: Thank you very much for your kindly welcome. You were very right in your speech, Sir James Turner, to dwell upon the grievous loss and hardship which fell upon so many when the sea poured over our coast defences on that last night of January. They have our fullest sympathy; their adversity is our opportunity to show the neighbourliness characteristic of our race. At many points farmers have sustained heavy losses, and the restoration of the land to productivity after being damaged by the salt sea demands action guided by the highest scientific and expert authorities.

I wish to thank you, Mr. President, for the broad-minded confident and virile spirit in which you have presented the vast and vital problem of British agriculture. I don't think I have ever seen so many farmers together before, and not all in their working kit, but after all British agriculture is no party issue ; it is a national issue. It is not a question of convenience but one of life and death for ourselves and for all we mean to the freedom of the world.

Fifty million people, maintaining a high degree of civilization and progress, distinguished by inventive ability and craftsmanship, and bearing forward the renown of a glorious past. Fifty millions, whose institutions and laws have shaped the future of so many lands, whose language plays a leading part in the modern world. Fifty millions, all dwelling in a small island, growing enough food for only, shall we say, thirty millions. That is indeed a spectacle of majesty and insecurity which history has not often seen before. There are therefore twenty million Britons, it may well be, who depend from day to day for what they eat upon their ability, which happily has never failed us so far, to sell goods and render services on and across the seas, in return for which we get the rest of our daily bread. Of course, we all know we could never have become a great nation, or even survived the perils through which we have passed in our own lifetime, if we had limited the sources of our strength to what could be found at home and had not roamed the globe armed with our wits and courage and will-power—let me say, yes, very important, will-power.

There is no question of choosing between food production and exports. We must have both at the highest level, driven forward with the fiercest energy. But we here tonight are resolved to proclaim that the home-grown food of Britain must with great urgency be raised by 1956 to 60 per cent above what it was before the war. That is a conviction which all political parties share, and all Britons in their senses are determined to sustain. There may be some that don't come within that classification, but I expect

you know them when you meet them or when you read any observations they may contribute to our guidance. Well, we have already raised our food production by over 40 per cent. The job must be finished, and finished soon, and when finished it is by no means the end—only the opening of a further task.

Ladies and Gentlemen, the balance between population and food supply has tilted to an uneconomic, unwholesome and dangerous extreme. A vast growing world towers up around us and reveals increasing strain and tension. Populations, as you have said, Mr. President, almost everywhere outpace the food supply. The difficulty of placing our exports mounts. We have got to alter the balance of this in this island. The balance of food production in this island has got to be altered in a marked and decisive manner, and altered soon.

I am absolutely confident from what I am told by good authorities, official and unofficial—ah, well, there is nothing like hearing all points of view you know—I am absolutely confident that the farmers can surpass the production target which the Government has set. Many of the necessities of life we have to import from the dollar area ; we are endeavouring to expand our engineering industry, but we find it increasingly difficult to compete in the world market with those countries, for instance, Japan—she does not enjoy the same standard of living as we do here in Britain—or indeed Germany, which is largely free from the burden of armaments which we now have to support.

It is just as important for our future now to wring the last ounce of food from our acres year by year as it was in the dark days of the war.

For this great task it is necessary first of all to give the farming industry solid assurance that the crops and livestock which are included in the 1947 Agricultural Act passed by our political opponents—but never mind, we are all in this together—will continue to enjoy assured markets and that the farmers will have a fair return for their exertions.

The policy of Her Majesty's Government is to make British farming stable, but that does not mean that it should be rigid ; it must be strong and free for adventure in greater and more efficient production. Our task in the second half of this century—everything gets more complicated as you go on—our task is to reconcile stability with freedom, and we propose, in consultation with the leaders of the N.F.U. to do this by steering a mid-course between the restrictions and interference of the 'forties and the hazards of the loose freedom of the early 'thirties.

As my Right Hon. Friend, the Minister of Agriculture, who is here tonight, and the Chancellor of the Exchequer—I am glad you have given him a cheer because he has a hard time—these two important colleagues of mine have repeatedly made plain, we stand by Part I of the 1947 Agriculture Act. Hitherto this policy of guaranteed prices and assured markets has been applied through a stiffly controlled economy, through a system of numerous and complex regulations, under which the Government has fixed the prices to be received by the producer, the prices to be paid by the consumer and the way in which each should vary from product to product and from season to season.

Her Majesty's Government are convinced that departmental intervention on this scale and to this degree with its refinement, if I may perhaps use that word in a complimentary sense, is bound to repress the urge for expansion and may well freeze the genial current of risk-taking and imaginative enterprise.

We are, moreover, convinced that the basic aims of the Agriculture Act can be secured by methods which allow the natural economic forces to work so as to reward enterprise in the producer, and allow the consumer to use his money to express his, or I think I must add, her, tastes on each occasion. Of course, Ladies and Gentlemen, the precise methods to be adopted will vary from case to case, and there will be many difficulties and intricate questions to be solved. These questions we intend to work out commodity by commodity in consultation with your leaders of the N.F.U.

We must have a live and healthy market, but we must see that it is supported by practical arrangements which ensure fair returns to the producer and will provide that if a slackening of demand is reflected in market changes, enough time is allowed to the farmer to adjust his production without impairing the long-term stability, upon which the fertile production of the soil depends.

Some people are very fond of forms and coupons, but you would have a bleak and thin meagre diet if you tried to keep yourself alive only by them. If we can do without them and still keep the essential basis of stability provided in the 1947 Act, away with them ! They should be cut down as far as they possibly can, and as soon as they possibly can. We are seeking, not in this sphere only, vast as it is, but throughout our whole field of Government, to liberate the full energies and ingenuity of the people. We can and we will bring about a greater measure of freedom for agriculture. In consultation with farmers' representatives, the corn trade, and others, we are now working out the best ways and means, but no one should lean too much on the Government, not even on this one. All that a Government can do is to create conditions within which the utmost may be produced from our farms and, let me add, our market gardens. I speak to those who are gathered here tonight. It is your industry, and only you can grow the food. For British agriculture, after thirteen years of close control, these are the days of opportunity and even indeed of high adventure. We believe that the more freedom the Government can give to the agricultural industry, subject to those other conditions I have not failed to mention, the greater will be their response and our reward.

Now, there have of late been murmurings from some quarters expressing a certain fear of freedom, but I am confident that this does not represent the feelings of the main body of our farmers. You, Sir, have spoken, Mr. President, with great firmness on the subject tonight. Many of our farmers are the best in the world, and they are by nature individualists and by their calling individualists, and proud of it. The more you produce, the happier British society will be. Your gain will be the nation's gain and we shall aid you in your task.

We realize, of course, that since 1939 there has been a farming revolution, perhaps no less far-reaching than the industrial revolution of the last century. The agricultural industry has shifted from horses to tractors. That is indeed a milestone in our pilgrimage. New implements have had to be bought by the hundred thousand. The use of fertilizers has more than doubled, and all kinds of machinery, which give farmers a new mastery, have become the tackle of ordinary daily use. Naturally this has involved an enormous increase in working capital. You, Mr. Chairman, referred to the need for capital and also I gathered to the lack of capital. These are stern times. When the present Government took office our national financial position was such that the Chancellor of the Exchequer—he had a hard job too—found it necessary to place severe restrictions on the supply of credit. You will, I am sure, remember that at the time when he did so he expressly asked

the banks to give special facilities wherever possible to the agricultural industry. This has, in fact, been done, and we intend that it shall continue.

That this and other difficulties are being surmounted is shown by the encouraging increase in agricultural production during the last twelve months. More tillage, more cattle, more sheep, and we now have a record population of pigs, the most prolific of all farm stock, are encouraging signs for the future. On behalf of Her Majesty's Government, I tell you that we shall back you in your efforts to make the fullest use of every acre, and we shall share in your pride of achievement as British agriculture shows the world what the land can give forth in this scientific age.

I will venture to repeat to you a quotation of an eminent American orator, who was a friend of mine long ago, a quotation which I have used before but which has always appealed to me and may well close a gathering like this where we are really talking about the solid needs of our country and the difficulties we have to face. Here is the quotation : *The earth is a generous mother. She will provide in plentiful abundance, food for all her children if they will but cultivate her soil in justice and in peace.*

THE EAST COAST SEA FLOODS

THE severity of the blow dealt to our agricultural production by the East coast floods has still to be fully measured. Only gradually will the sum total of damage and loss sustained by farmers in the coastal areas become completely apparent. But the first estimates already foreshadow the magnitude of this tragic and widespread devastation by the sea. Some of our most fertile arable land and grazing, reclaimed by long and patient labour and at high cost, has literally been snatched back overnight. The fateful weekend of January 31—February 1 will be remembered as marking one of the most serious farming disasters of the century.

The piled-up waters of the North Sea, whipped by a widespread northerly gale of greater than hurricane force to unparalleled tidal levels and to an unbelievable force and fury, smashed through the sea-wall defences in hundreds of places along the coast from Spurn Head to Kent, to inundate the low-lying land beyond. Under the pressure of the water, thousands of tons of stone and concrete were crumpled and scattered like a child's bricks, as is shown by the picture on our front cover of the broken sea-wall at Mablethorpe in Lincolnshire. Houses and farm buildings were swept away, fields were turned into lakes, streets into rivers, and whole communities isolated. Besides the grievous loss of life totalling 307 people, over 32,000 had to be evacuated from their homes, and some 7,000 had to be looked after by public authorities for some days.

Emergency measures, provided for after the 1947 floods, were brought into force immediately. Civilians and servicemen worked side by side in biting wind and rain in a desperate attempt to rescue marooned people and livestock, to repair the havoc and block the worst of the breached walls with sandbags, stones and any other material to hand. The stories of human endurance, courage and selflessness that have come out of this disaster are of an epic quality.

Every kind of farm has suffered from this devastation by the sea, including market gardens and smallholdings, besides good grazing—in all something like 150,000 to 175,000 acres of agricultural land ; of this about 64,000 acres were arable and some 79,000 acres grassland. By good fortune, two-thirds of the flooded areas was under water for only a comparatively short period, and it is estimated that only about one-third of the total area flooded will have been really seriously affected by the salt water. The prompt and excellent salvage work by the local farming committees prevented losses of livestock being as heavy as at first feared. Nevertheless, upwards of 1,000 cattle, 8,000 sheep, 1,500 pigs and about 20,000 poultry succumbed. For some farmers the floods have meant the loss of whole herds and flocks and the destruction of a lifetime's labour. To this we must add the loss of, and damage to, farm equipment and stocks of feedingstuffs—a whole range of farming capital—that cannot readily be made good, even when the water has been pumped off the land.

One of the areas which suffered most was around Mablethorpe and Sutton in Lincolnshire. Some of the biggest agricultural losses, too, have been sustained in the south of Essex, Foulness Is., Wallasea, Potton and Canvey Is. have all been practically submerged. Acres of glasshouses serving Southend-on-Sea have been smashed and their crops ruined.

Salt in the Soil Although the total area affected is much less than in the winter of 1947, when 700,000 acres over thirty-one counties were inundated, the damage to the land is likely to be very much greater. In 1947 it was the volume of melting snow which caused the rivers and drainage system to overflow. The effect of salt water and the deposited residues of salt is much more serious and persistent. In his broadcast on February 6, Sir James Scott Watson, the Ministry's Chief Scientific and Technical Adviser said : " Our common crops will not grow so long as there is a lot of salt in the soil. Some can tolerate more than others. About a ton and a half of salt per acre of soil is pretty safe. Beet will stand two tons, barley perhaps two-and-a-half, and the common grasses from three to five. But in many cases the amount of salt may be more even than that. The first thing that we can usefully do, at the first possible opportunity, is to clear the ditches. It will help also to open shallow surface channels—water furrows—to help the drainage. Only in making such, farmers should avoid taking heavy implements over the ground, even if the surface seems fit to carry them. If we puddle the soil while it is still full of salt, we shall do more harm than good.

" It would be a help, for the next stage, if farmers could keep a note of the history of every field—of the time when the various parts were first clear of water. Our Soil Chemists, in the National Agricultural Advisory Service, are getting organized to carry out salt analysis of big numbers of soil samples. But there may be a lot of variation within a given field. Pools that have stood for long will leave very salty patches. The ideal assistance for our samplers would be a set of maps, made at weekly intervals, for each field, from the time that dry land first appears.

" How long it will be until the sea-flooded land becomes fit to grow crops depends on a lot of things : on the time that the land has been under water ; on the rainfall ; and on the nature of the soil—whether sand or clay or loam. Cases are known of sandy land that has been sea-flooded for a fortnight and has carried a good crop after only one winter's rains. At the other extreme, heavy land reclaimed from the sea may be unfit to produce anything but grass for about five years.

"Is there anything we can do to hasten the clearing of the salt? Gardeners—including market gardeners—if they have the necessary water supplies, can spray the land. But spraying will be most effective if done in winter; that is to say, when evaporation is low. Light sprinkling in summer will only make matters worse. The other possibility is to copy the system which the Dutch have worked out—a method that shortens, by nearly half, the time that would otherwise be needed. It depends on the application of big dressings of gypsum."

The first job is to get the main and subsidiary watercourses clear of silt, and as soon as the land is fit to enter the soil should be sampled and analysed, so that the farmer can be advised of the best course to take in his own individual circumstances.

Grassland.—Land carrying a good turf or a certain amount of "mat" suffers little structural damage to the top soil, and since this remains permeable the looser soil, if drainage is adequate, is fairly quickly leached. Ploughing would probably bring structureless material to the top, and thus slow down the clearance of salt.

In general, the land should be left until the summer, when the extent of damage will be assessable. It may be grazed by cattle and sheep, with due precautions. By the autumn, or the following spring, surface cultivation and surface seeding with the more salt-tolerant species (especially ryegrass) may produce a reasonably good sward. Application of gypsum would achieve little or no benefit. Ploughing and reseeding should not be attempted without fresh assessment of the position.

Arable Land: Gypsum Treatment.—Gypsum will be supplied free, delivered at farm, where required. There is little to be gained by early application, since it depends for its action on being dissolved in rain and washed into the soil. It is best left on the surface, since the amendment of structure must proceed from the surface downwards, but a chain harrowing may help to improve distribution. Two or three inches of crumb on the top will enable some crop (or grass) to be established, and the root action will then expedite the rebuilding of soil structure.

The amount of gypsum likely to be dissolved in an average winter is little more than a ton per acre, but the amount required for complete restoration may be 4 tons or more. It is therefore recommended that a dressing of 2 tons (dry weight) per acre be applied during dry weather in the summer or autumn of this year. Much of the gypsum available is damp (about 30 per cent moisture). Delivery should be taken at the earliest opportunity, and the material built into a steep-sided clamp, preferably thatched. Its friability may then be expected to improve during the summer.

Under certain circumstances—orchards, market gardens, etc., on *free-draining land*—it may be possible to expedite the clearing of salt either by spray irrigation or, on tolerably level land, by flooding with fresh water. The amount of water required for the initial treatment would be the equivalent of about six inches of rain, applied as fast as the soil will absorb it. Further applications should be sufficient to cause the drains to run freely.

THE WORLD IS SHORT OF FOOD

THE world food picture was broadly sketched by Mr. Frank McDougall speaking from Rome in a B.B.C. broadcast on January 15. Mr. McDougall has been on the staff of the Food and Agriculture Organization ever since its inception in 1943, and for many years before that he was associated with the food problems which an expanding world population has brought into prominence.

Mr. McDougall said that F.A.O. is giving technical assistance to some forty under-developed countries, and that as a result of these activities it is convinced that it is clearly technically possible to bring about great improvements in agricultural production—mainly by increasing crop yields from land already under cultivation and from livestock. But many countries have social, administrative and political difficulties—barriers such as obselete land tenure systems, inadequate education and transport facilities, and a lack of incentive due to poor marketing arrangements and heavy burdens of debt. Steps are being taken to overcome them, but it cannot be done quickly.

Our Aim must be Higher Yields Something could, admittedly, be done to bring more land into cultivation by clearing forests, irrigating deserts, draining swamps, and so on, but that is not the real solution. True, there are large areas of forests, but some of these are in the temperate zones, where they are needed for timber and for wood pulp and to check soil erosion. And there are the rain forests in the tropics, but we do not yet know how to maintain the fertility of such areas once they have been cleared. We shall find out, but it will take time. There are huge areas of deserts, but deserts are deserts because of lack of water. Much can be done by irrigation and the tapping of underground water, but the total water resources are limited. Swamps can be drained, but the area so affected would be relatively small. Most of the easily workable land in the world is already being used. Developments will be expensive and unlikely to provide cheap supplies of food. More can probably be done through increasing yields than through bringing new land into cultivation. And this means that it is up to the farmers of the world and those who assist them to make the principal effort.

There is no justification, continued Mr. McDougall, for farmers to be apprehensive of large stocks of foodstuffs piling up and adversely affecting prices. Some farmers are still thinking of the 1930s, but the situation today is very different. All the economically advanced countries plan to maintain full employment with the intention of preventing a major economic depression. We should not be worried, but *glad*, of the existence of substantial stocks. In many parts of the world there is need for more food imports. Before the Second World War Asia was exporting food grains; last year Asia was a net *importer* of some 8 million tons of food grains. " It is, I believe," said Mr. McDougall, " most important that the people of food importing countries like the United Kingdom, should realize the significance of the world outlook for food supplies as a matter of most serious concern to themselves ".

Briefly, the situation is that the world has become more dependent upon North America for its supplies of food. Before the war, the United States and Canada together produced about a fifth of the world's agricultural production ; this proportion has now increased to nearly a quarter. This dependence involves the great major problem of balances of payment and the possibilities of drought. The number of food importing countries has

now grown, and then again, countries such as Germany and Japan are in need of larger food imports and they are becoming more able to pay for them. There is no doubt that world food exports could be substantially increased, particularly from such countries as the Argentine and Australia, but in both those countries the tendency to industrialization has limited their food exports. If Britain and the other food importing countries are to be assured of adequate supplies over the next decade, farmers, both at home and abroad, must have sufficient incentive to increase output, and the necessary agricultural resources and skills must be provided.

Challenge to the Individual Farmer The point that we must look to the individual farmer for increased food supplies was emphasized by Sir James Scott Watson who spoke in the same programme. "In spite of all that is being attempted," he said, "food production in the world is not keeping pace with growing needs. There is a real, big and growing scarcity ; it is of great importance to us, for the United Kingdom is still the biggest buyer of food in the world market, and nowadays we have to go shopping with a slender purse. Maybe we can get by, but it will only be through the united efforts of our farmers and farm workers and all the other people concerned—manufacturers, merchants, research workers, etc., who are helping to provide the better tools for the bigger jobs.

"Our Government has set the task for the next four years. It boils down to making nine acres do the job of ten. There is no general recipe for higher production. Every farm is different. But there are a few things that are pretty generally true. First, that on three farms out of four the higher production that the country needs will pay. From time to time, I look at the cost accounts that our economists make up year after year, and it is abundantly clear that the men who are doing best for the country are those who are doing best for themselves. Those who are using all their knowledge and skill to grow bigger crops and better grass, more milk per cow and so on.

"The second thing is that taking the country as a whole, our grassland farming is less good than our arable farming and our livestock breeding. Our grasslands could do far better. The general plan must be more leys, sown with the right kind of grasses, more frequent help with fertilizers, strip grazing of dairy herds and maybe with other kinds of stock too, more silage and better quality hay. We also need more corn—any kind, wheat or barley or oats or dredge, it doesn't much matter. And it is quite possible nowadays, supposing you can't find the labour to grow roots, to work nearly any sort of land on a single rotation of leys and corn. Many farmers on a wide variety of soils are doing that—and doing well.

"The change-over to ley farming is a biggish venture, perhaps too big. This new intensive system of grassland management, heavier manuring, strip grazing, silage and all that, is pretty revolutionary. But it need not mean a revolution of the whole farm. The first thing is to make a start. A field or two this year and another field or two next. And then, having started, to go forward steadily, step by step, year by year, making simple changes that will help our pockets.

"There are many problems, I know—scarcity of workers or housing for them ; money is tight and taxes are high. But I hope we shall take all these things as a challenge and get over them one way or another".

RESEARCH FOR PLENTY

No. 5. ALL FLESH IS GRASS

NORMAN C. WRIGHT, M.A., D.SC., PH.D., F.R.I.C.
Chief Scientific Adviser, Ministry of Food

BECAUSE animal products are relatively costly to produce and are an expensive item in the family budget, we too easily assume that their liberal consumption must always have been something of a luxury—part of the diets only of the richer populations of the world—to come nearer home, only of those of the higher income groups within our own country. Such an assumption neglects completely the historical background of man's food supply ; it literally puts the cart before the horse. In historical time, the pastoralist succeeded the hunter, but he preceded the cultivator. Tillage furnished to Neolithic man but little of his food ; by far the greater bulk of his provisions came from his livestock, as witness the immense quantities of bones of cattle, sheep and pigs found in the ancient Neolithic camps. Those were in truth the days when all flesh was grass, for wheat was then the only cereal grain, and even so only in small hand-tilled plots.

Although five thousand years have passed since the Neolithic age, grass still remains the staple foodstuff for our stock. In this country grasslands cover an area nearly three times as great as that of all the arable and horticultural crops combined ; and grass and grass products (such as hay and silage) furnish three-quarters of the home-grown nutrients for animals. In the world at large these figures are roughly paralleled. Of the total of 13 million square miles of land occupied by man, more than two-thirds are covered by permanent pastures. Moreover, to this vast expanse of grazing must be added the semi-arid and desert regions of the world covering an area as big as Africa, from large parts of which stock, grazing nomadically, can gain in the rainy and post-rainy seasons the herbage which indeed " blossoms as the rose ". If conditions in British colonial territories can be accepted as typical, the distribution of stock between the predominantly pastoral and the predominantly settled areas reveals even more strikingly the contribution of grazing to livestock production ; for the pastoral areas support five times the cattle, ten times the sheep and goats, and over twenty times the camels and equines found in the settled areas.

Seasonal Grazing The grazing grounds of the tropics thus offer a useful starting point for considering the outstanding problem of livestock husbandry, in that they illustrate to an extreme degree the difficulties and dangers to stock that result from the seasonal fluctuations in the growth of natural herbage. In such areas the growing period extends over not more than six months of the year. During this period the rains produce a quick-growing and lush herbage from the seeds of the previous year's annual grasses, which have been dormant throughout the long dry period. When the rains cease, such herbage first grows to a coarse and fibrous stage, then dries and then—as drought persists—disintegrates to leave a surface bare of fodder. Thus there arises the need for a system of nomadic husbandry where stock can move from area to area in a constant search for moisture and for grass.

The effects on animals of this extreme seasonality in the growth of herbage, and of its inevitable accompaniment of nomadic movement, can be seen in the poor gains in weight and general low level of productivity of nomadic stock. An animal may gain a hundred pounds or so while grazing in the lush season ; but, as a result of lack of nutrients and of the loss of flesh involved in the enforced search for new pastures, it may well lose at least half this increase in the leaner periods. Indeed, a severe or unexpected drought may lead to literal decimation of the herds and flocks. Over many generations of such nomadic life, types of stock have however been evolved which are physiologically adapted to such a constantly changing and treacherous environment. Perhaps the best known is the camel, whose hump consists of a vast store of fat (not, as is commonly supposed, of water) built up in the lush period and available as a mobile reserve when grazing fodder fails. This surprising creature is one of the best examples of a climatically adapted multi-purpose animal. Employed for both riding and baggage transport in the desert, it can also be used for draught in the settled areas and on the lighter cultivable soils. But, *par excellence*, in the desert and semi-arid areas it forms an invaluable source of meat, closely resembling in taste the local beef, and it is no less valued for its milk. As by-products, the camel provides both hides and hair, and under desert conditions its dried dung is even used as fuel.

The camel is perhaps the most extreme and best known case of adaptation to seasonally productive grazing lands. More important in both numbers and value are the fat-tailed sheep common, in one variant or another, to the vast tracts of desert of both Africa and Asia. Here the reserve of food lies in the tail or, with the Somali breeds, in the greatly enlarged rump. In the lush period the tail may expand to attain a weight of 10–15 lb. or more ; historical records place the figure nearer 50 lb. ! In the lean period the tail slowly degenerates into a hollow bag or, with the long-tailed sheep, a cord of empty skin, ready for re-filling from the herbage nutrients of the next season's rains. So, too, the zebu cattle of the tropics carry their food reserve in their enlarged hump as an insurance against their far from rainy days. Moreover, it is not only in their mobile food reserves that such animals adapt themselves to their specialized and harsh environments : their mouths and their digestive tracts are adapted to sources of foods which would be foreign to our more gently nurtured and domesticated stock. The camel thrives on thorn trees and on the coarsest fodder—acacia, tamarisk, zizyphus and camel thorn. The goat, too, like the sheep, provides in desert and semi-arid areas both meat and milk and skin and hair, but does so by reason of its capabilities for browsing on the most unpromising of trees and shrubs. And the semi-domesticated pig, with its long snout and razor-like back, secures its nutrients in its natural habitat as a scavenger of woods and roots.

Integration of Crops and Stock Such seasonality in grass supplies is not confined to tropical areas. Indeed, the earlier techniques of stock production in this country, as recorded up to the fifteenth and sixteenth centuries, were essentially based on seasonal grazing ; surplus stock were slaughtered off the grass, to avoid the cost of nutrients for winter keep—a tendency which, even to the present day, markedly affects the seasonal nature of this country's meat supplies. But the integration of livestock needs with cropping husbandry, which found its earliest expression in the semi-nomadism of the tropics and has developed to the full in our own more modern system of mixed farming, introduced a new and mutually beneficial element into crop and livestock husbandry. Developing primarily

from the use of the ploughing ox as a substitute for manual labour, the animal came (particularly following the enclosure of the common lands) to hold a unique place in the cropping systems of our tillage areas.

In this integration of crop and stock, animals fulfilled a threefold purpose : first, for draught ; second, as consumers of those portions of the crops which were inedible to man ; and third, as the medium for inducing increased fertility in the soil. The first, draught, requires no elaboration, except to state that until quite recent times it was the dual-purpose ox and not the single-purpose horse which enjoyed the greatest popularity. The horse, indeed, seems destined to enjoy a relatively brief spell as an important farm animal : having only with difficulty displaced the ox, it is itself now being rapidly displaced by oil-powered tractors.

As regards the second purpose, the function of livestock as consumers of inedible by-products, if you examine the sources of our animal feeds you will find they are largely derived from such by-products. Thus, where man consumes the refined flour from the wheat grain, animals subsist on the coarser milling offals and the straw ; where man derives his margarine from oilseeds, animals utilize the unpalatable cake and meal ; where man extracts his sugar from the beet, animals thrive on the rejected tops and pulp ; where man derives his nourishment from butter with cheese, animals consume the separated milk and whey ; where man selects the choicest portions of the carcass, animals fulfil the role of scavengers in disposing of the offals of the slaughter-house ; where man regales himself with beer, animals enjoy the cognate taste of brewers' grains.

As regards the third purpose, the value of livestock in maintaining soil fertility in cropping areas, the role of stock is twofold. By the adoption of ley farming, that is, by alternating crops with grass, the productivity of the land is enhanced through the beneficial effect of grass in preserving soil structure, a point which Dr. Walter Russell made*, in adding humus and nutrients to the land, and in avoiding the risks inherent in a system based on monoculture. And by the return to the land of dung or urine, either to the ley or to the crop itself, the animal adds to the productive value of the soil. It is difficult to assess the value of this integrated system of mixed farming in quantitative terms. If it were not too great a simplification, one might refer to the comparative yields of crops in this country on our *intensive* farming system with those of the *extensive* farming systems of the countries of the New World, where wheat, for instance, barely gives half the British yield, and other cereals common to us both show comparable differences.

Animal Protein and Fat in Human Nutrition

But side by side with these primarily agricultural uses of livestock, man has come to appreciate for their intrinsic value as a source of human food the direct products of the animal : milk, eggs and meat. For by their passage through the animal, the proteins of the plant are not only improved in quality, resembling more closely in pattern those constituting the human tissues, but they are present both in far higher concentration and in more readily available form than in the plant. The protein content of the dry matter of grass ranges, for instance, from 10 to about 20 per cent ; that of milk, cheese, eggs and meat ranges from 30 to as high as 50 per cent. Again, while the proportion of fat in the dry matter of plant tissues seldom exceeds 5 per cent and for the staple cereals is less than half this figure, in the dry matter of milk the proportion is over 30 per cent, in eggs over 40, in cheese

* *Agriculture*, February 1953, **59**, 503-7.

over 50 and in fat meat over 80 per cent. This process of concentration applies also to the mineral elements and vitamins, thus conferring on many animal products an exceptionally high value as "protective" foods.

Such properties are alike of special value to the industrial worker and to the so-called vulnerable groups of the population, the expectant and nursing mothers and young children. To the industrial worker they furnish (especially through their high content of fat) maximum energy value in minimum bulk ; they therefore give to the worker's diet a "lasting" value which cannot be provided by a diet composed largely of bread and potatoes. To the vulnerable groups, animal products furnish the best quality protein, the high proportions of minerals which are essential to skeletal growth, and the vitamins which are particularly needed by the young for the maintenance of full health. What is more, the importance of such products in ensuring variety and palatability in what would otherwise be a dull and monotonous starchy diet is something we cannot ignore, if only as a means of stomaching the needed quantities of cereals and vegetables. Indeed, apart from sugar, margarine and fruits, animal products provide the only staple and attractive variants for our daily meals.

I might perhaps emphasize here that even the most convinced vegetarians usually recognize the need for including in the diet a reasonable proportion of animal products, usually in the form of milk, cheese and eggs. Indeed, calculations show that a planned vegetarian diet (or, more accurately, a lacto-vegetarian diet, for the normal vegetarian only eschews fish, flesh and fowl) frequently provides up to two-thirds of the quantities of both animal protein and animal fat contained in an ordinary mixed diet ; it is only where a vegetarian diet is accompanied by a low total food intake (as in some of the densely populated Asiatic countries) that the proportions of animal protein and animal fat fall seriously below this level.

Why not a Vegetarian Diet ? This brings me to the crux of the problem of livestock products in human economy. It has frequently been urged that such products are so wasteful that, to meet the rapidly expanding food needs of the world, we should eliminate them from our diets and all adopt a more or less vegetarian regime. At first sight, this is an attractive thesis. Not only is the gross weight of the world's livestock population at least twice that of the whole human race, but domesticated animals eat—at least in Western countries—five to ten times the amount of food consumed by man. One reason for this striking disproportion is the difference in the growth rate and productivity between animals and man. Thus within a life span of, say, ten years, a dairy cow will reach a weight of something like 1,000 lb., will produce six calves each weighing 60–80 lb., and will furnish nearly 20 tons of milk. The total dry matter contained in the resulting tissues and secretions will amount to over 5,000 lb. During the same period of time a child will have attained only the birth weight of a single calf, corresponding to 20 lb. in terms of dry matter.

Nevertheless, such stupendous gains in weight and levels of output do not lessen the acknowledged fact that in the process of conversion of plant into animal products, livestock utilize only about one-sixth of the available plant nutrients ; the remaining five-sixths are either rendered unavailable to man in the inedible portions of the carcass, or are excreted as waste products. Can such an apparent waste be tolerated in a world suffering from an acute food shortage ? Part of the answer I have already given. Animals subsist in the main on foods which are themselves inedible to man—

on grass and straw and unpalatable offals and by-products. Moreover, the apparent waste in the excreta is not in fact a total loss ; it returns to the land (and largely to the tillage land) humus and nutrients vital to its soil fertility. Further, those portions of our livestock food such as cereals and pulses, which are derived from first-class cropping land, are largely used to supplement, and not to replace in their entirety, the nutrients derived from grass and humanly inedible material. Thus they are capable either of enhancing the otherwise low level of production (thereby increasing the animal's comparative efficiency), or they ensure the maintenance throughout the lean seasons of the gains attained throughout the lusher periods. This, in the temperate zones, is the reason for allocating " winter keep " to stock, and, in the tropic zones, the reason for the growth of semi-nomadism.

If, then, it is accepted that animals do fulfil a useful, indeed a vital, role in both our agriculture and our dietary needs, we must clearly look to other methods by which to increase the economy of production of our livestock products. In the desert and semi-arid areas, indeed in most predominantly pastoral regions of the tropics, the problem is essentially that of improving both the production and utilization of the grazing herbage, of providing more ample water supplies and, where possible, of increasing the practice of semi-nomadic husbandry.

But in the predominantly settled regions, particularly in the temperate areas, improvements must be looked for, not so much in the environment or even in the techniques of husbandry, as in the efficiency of the animals themselves. Further efforts must be made to increase individual productivity by better planned and more widely adopted methods of recording and selection. Disease, at present taking toll through both mortality and decreased yields and growth rate, must be more quickly diagnosed and controlled. Feeding methods on which efficiency of food conversion must in the last resort depend, must be brought into line with the newer knowledge of rationing and of intensive grazing techniques. And grass itself—from which indeed all but " all flesh is made "—must be relied upon increasingly to bear the burden of our present, and of our future, livestock populations.

SOCIAL PROBLEMS IN THE DEVELOPMENT OF LIVESTOCK REARING AREAS

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Agricultural Land Service Research Group, Ministry of Agriculture and Fisheries

The more rigorous life of the upland areas sets sociological problems which need to be remedied if farm labour is not to be lost and the increased production of store stock is to be realized.

MANY of the upland areas of England and Wales suffer from a variety of drawbacks which are so closely interrelated that they constitute both cause and effect at one and the same time. The vicious cycle of events shown in Fig. 1, on p. 565 represents, in a simple diagrammatic way, the type of problems which occur in areas such as central Wales, north Devon and the Border country.

Natural factors usually create and maintain this vicious cycle if they are allowed to operate unchecked. High altitude, rigorous climate, poor drainage and, often, thin soil give rise to poor quality land. These physical limitations affect the choice of farming system, restricting it to types such as sheep and cattle rearing which employ relatively few people. The land, being rolling and broken, has been settled in the form of isolated farms and hamlets with few villages or towns. Accessibility is poor and social and physical isolation, coupled with a history of low levels in personal incomes and living facilities for most of the rural population, have led to a gradual loss of people ; especially of those between 16 and 30 years of age. The result is that not only are there fewer and fewer people living in the hills and uplands, but an increasing proportion of those who remain are old people, disinclined to change. For example, the population of Glendale Rural District in Northumberland declined from 8,500 to 7,500 between 1911 and 1951. At the same time, the proportion of people over 65 years of age in the district increased from 7.9 per cent in 1911 to 9.5 per cent in 1931 and then to 12.8 per cent by 1947. This ageing of the population has been common all over Britain, but its effect has been most marked in isolated country districts. It is not always appreciated that the size of the rural household is thereby becoming smaller and that a greater number of houses relative to population is needed in these districts, as compared with the flourishing towns and thickly settled lowlands.

It is recognized that, in the past, some districts may have been over-populated in relation to their limited natural resources, but it is equally obvious that rural areas with a dwindling population have less and less likelihood of obtaining those advantages such as piped water and electricity and better bus services which might induce people to stay in them. Yet, without those very amenities, more and more young people will be attracted away from upland areas towards the towns or more favoured parts of the countryside.

The Farm Labour Problem in Upland Areas

Although people have left the upland areas, the need for farm workers has not diminished. Greater productivity from either grassland or arable is of little value if there are insufficient livestock available to utilize it or enough people to look after the stock. Moreover, there is a continued and unavoidable demand for labour, since mixed and livestock rearing farms are incapable of complete mechanization.

Fortunately for the country the small family farms, typical of so much of upland Britain, have provided a supply of "cheap" labour and so permitted the continued farming of such areas. Even so, there is a drift of daughters and younger sons away from these farms and, equally important, a drift of the more progressive farmers to better lowland farms. It is probably only the great, unsatisfied demand for farms of any kind at the present time, together with the recent price and grant discrimination in favour of rearing farms, that has prevented this latter tendency from becoming more marked. In certain districts there has been, and is today, a move towards the amalgamation of holdings, especially of hill sheep farms and farms lying towards the ends of glens, dales and cwms. Actually, a strong case for larger farms in the rearing districts can be made out on economic grounds, based largely on a better use of labour and higher output per man.

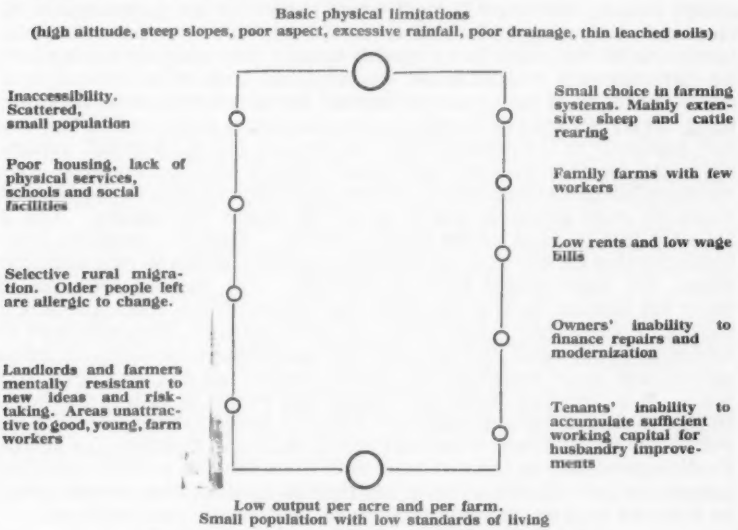

Fig. 1. Cycle of Events in Marginal Farming Areas

Whether the small family farm remains the typical holding of the rearing areas or larger units using more hired labour come into being, there remains the need to attract and retain enough people to farm an area efficiently and to justify the provision of at least a certain number of amenities. From the farmers' and landlords' points of view there are two different and yet related sides to the farm labour problem. In the first instance, farm earnings must be sufficient for the occupier to pay wages high enough to attract the numbers and quality of workers which his holding requires. At the same time, living conditions, both as regards housing and social amenities, must be such as to retain labour on the farm and in the area. Most farmers have direct control over only a few of the conditions governing living conditions. By individual action, or in co-operation with a tenant, new cottages may be built on a farm or old ones modernized and, in exceptional cases, water and electricity from private installations can be, and are being provided. Yet there remains a variety of factors—frequency of bus service, distance from a school, shop or village hall—over which the individual farmer has little direct control.

Effects of Government Help Certain work has been done in recent years to tackle this twofold problem. Under the terms of the Hill Farming Act, passed in 1946 and now continued and extended by the Livestock Rearing Act, the Government has made and is continuing to make available considerable sums of money to tenants and landlords, by offering to provide 50 per cent grants towards the cost of an approved, comprehensive scheme of improvement to land and fixed equipment on hill and upland farms. Improvements eligible for grant-aid are very varied and include construction and repair of buildings, farmhouses, cottages and roads, drainage and fencing, bracken eradication, planting of shelter-belts, cultivations and application of fertilizers, and the provision of water and electricity. Subsidies are also paid on hill sheep and cattle.

When examining the effects of this financial help it is important to differentiate between the true hill areas where comprehensive improvements to farms have been going on for several years, and the lower rearing areas where farmers, until 1951, have had as special benefits only relatively small grants for improvements of land under the Marginal Production Scheme, and where the effects of the Livestock Rearing Act have not yet come fully into being. In certain areas of the hills the benefits gained under the Hill Farming Act, especially in the modernization of cottages and the livestock subsidy payments, together with the high prices recently obtained for wool, have put many hill sheep farms into a sufficiently prosperous state to provide high wages for good shepherds and to get all the labour they require. This is certainly true in parts of the North Country. There is, therefore, some indication that the first of the problems, namely, the ability to offer attractive wages, has been tackled fairly successfully. The physical resources of many hill farming districts are such that the population which the area is capable of supporting, unless there are other activities complementary to agriculture, is so small and scattered that the extended provision of public services and social amenities can scarcely be justified and may never take place. It is therefore of first importance that people in such areas should be able to earn an income sufficiently high and steady to permit them to use public and private means of getting freely in and out of their farms or houses. Public expenditure on isolated schemes of improvements to farms and farm cottages in such districts as these can then be justified, even though it may be divorced from any radical improvement to general social conditions.

In the upland rearing districts adjoining the hill areas the case is rather different. Improvements to farms under the Livestock Rearing Act were started only about eighteen months ago ; only a minority of the farms have been eligible for the hill sheep and cattle subsidies, and wool is not usually quite so important a source of farm income. Moreover, in the areas as a whole, the population is denser. The agricultural potential is underexploited, frequently as a result of poor living conditions. These upland rearing areas, therefore, because of their greater density of population and a less prosperous agricultural economy in recent years, need a different kind of curative treatment.

Among rural deficiencies, poor housing and lack of piped water are probably the greatest drawbacks to country life in the eyes of most people, but lack of electricity, inadequate sanitation, scattered schools, infrequent bus services and isolation from shops or entertainment are equally great disadvantages in the eyes of some families or individuals. The provision of some of these facilities is a matter for local private enterprise, but local and central government bodies as well as public boards are concerned in supplying four of the more important deficiencies—housing, schools, piped water and electricity.

It is clear that the total of deficiencies in these four items, over the country as a whole, is so great that it will be a very long time before there is enough capital available to bring all rural areas up to a uniformly high standard. Some form of discrimination in the investment of capital seems, therefore, to be required. With this in mind, a survey of rearing areas in Northumberland has recently been carried out to show the weaknesses and strengths of different rural districts.

Some Examples from Northumberland For the purpose of this survey, the rearing areas of Northumberland, shown in the map (Fig. 2) were divided into a number of natural or physical units. The conditions in each of these were studied and a grading from "A" to "E" was given in respect of the following factors : land quality, social provision, accessibility, educational programme, water supply, electricity, and farm labour trends. All the factors are not thought to be of equal significance, and it was necessary to establish some order of importance to resolve possible conflicts in the grading. The order adopted was that in which the factors are listed above.

Land quality was measured by a combination of a physical land classification with differences in "natural" grassland. Social provision included such things as numbers and types of shops available in the different villages and market towns, and the presence or absence of professional men such as doctors and dentists. The relative accessibility of different places was measured by bus services and the distance from roads along which public transport ran. The educational policy of the county was important in that the present and future attraction of many villages and towns are being significantly altered by decisions about the location of new secondary schools and the closing or improvement of certain village schools. In the provision of piped water and grid electricity, the authorities controlling these important services have very definite programmes and very definite ideas as to where it is and is not economical to extend them. Finally, there are big differences between farming areas in the county in the history of their ability to attract and hold regular agricultural workers.

These factors combined give an indication of the strengths and weaknesses of different areas both as places in which to live and as areas in which to farm. When this had been done it was possible to distinguish among them certain "types" which one might expect to find reproduced in other parts of the country.

Wansbeck Valley

At the top of the list was an area west of Morpeth in the Wansbeck valley where many farms practise fattening as well as rearing, and consequently some of the holdings are ineligible under the terms of the Livestock Rearing Act. The area has relatively good land, good internal social facilities and good access to Morpeth and other centres. It is also fairly well served by schools, piped water and electricity, although there is some room for improvement. The supply of farm labour is not too satisfactory and the provision of housing could be better. An attack on the problem of providing more cottages is clearly indicated in the case of this area. There are other similar areas in the country where relatively small expenditure on one type of deficiency might lead to greater agricultural productivity. In this particular case, there are two possible ways of providing more cottages—by Livestock Rearing Land grants towards their erection or improvement on individual farms, or by the building of houses by local authorities.

Fig. 2. The Livestock Rearing Areas of Northumberland

Hexhamshire

This district, lying south of the Tyne valley, affords an example of another type of area with much poorer land and fewer services and facilities than the Wansbeck valley. It resembles the latter in its comparative accessibility to urban centres (Hexham and Newcastle) but differs from it in that most of the holdings are small family farms, often producing milk, and that the labour position is fairly satisfactory. Hexhamshire appears to need more extensive electricity and water supplies and a wider range of social facilities : for example, the health services are very poor. The need for these improvements does not appear to be so urgent as does the need for more cottages in the Wansbeck valley area.

Upper Cocquetdale

In an intermediate position on the list of priority is Upper Cocquetdale, one of the most interesting areas of the whole county. Its potentialities are by no means fully exploited, largely because of its inaccessibility. Social facilities and physical services are largely confined to the south and east, and in those areas they are, on the whole, adequate. From the educational point of view, the area is a difficult one ; children have to travel to Alnwick for grammar and technical education, while several of the junior schools in the area are to be closed under the School Development Plan.

This area appears to offer considerable possibilities for increasing agricultural productivity by the intensification of the farming system. There are possibilities for extending water and electricity supplies, and existing hamlets and a regional centre need to be revitalized. The problems of inaccessibility and education are difficult, but if more people could be attracted to live in the area the latter problem at least might be solved. It is important, therefore, to consider possibilities of activities other than farming—tor example, a holiday trade or afforestation on some of the surrounding moorland. There is a clear need for a more detailed survey of the possibilities and requirements of this area.

North Tyne and Rede Valleys

Forestry has already made a major difference in the conditions found in another area of the county—the North Tyne valley and adjacent moorlands. Land quality in the area is low, consisting mainly of *molinia* moor, with slightly better quality in-bye land in the valleys. Despite their poor natural resources, the North Tyne and Rede valleys attain a fairly high grading in respect of facilities and services, a fact which may be attributed to the introduction of forestry. This has brought better roads, electricity and more people to areas which would otherwise not have seen them. As the forest becomes more advanced and more workers are needed, the position may become even better, although it is doubtful whether there will ever be enough people in the area to justify better educational facilities than those at present envisaged.

Cheviot Foothills

In the far north of the county among the Cheviot foothills, there is another interesting area of a very different type. Land quality here, as on the whole of Tweedside, is good, but owing to the isolation of the area, its poor housing and general lack of attraction, it is a real under-developed agricultural area. This area has only two small settlements with few social facilities in them ; there is no piped water, few schools and only a small portion is served by electricity. Farm cottages are in the main obsolete and it is not surprising that this area shows the greatest proportionate decline in numbers of farm workers between 1938–50 as compared with other rearing areas. There appears to be little hope of improving the labour supply of the large rearing farms of this area unless some major improvements are made in living conditions, especially housing. This area differs to some extent from the others in that it constitutes part of the much larger problem of Tweedside.

Combined Action Necessary Enough has now been said to show the wide variety in the possible combination of problems which are to be found in our rearing areas, and it is clear that the agriculturist and the town and country planner should combine to tackle the deficiencies. There will be some areas, notably in the true hill districts, where major public social investments cannot be justified by the small, scattered population. Apart from these, there is a wide range of countryside

where the problem varies from remedying one or two minor deficiencies to the necessity for large-scale schemes of regional development.

The problem of allocating our limited capital resources has been discussed here as if it applies only to the livestock rearing areas, but this is patently not the case. There are other areas of greater agricultural potential which may have better claims on existing restricted capital ; for example, areas suffering from bad drainage or liability to flood. Consideration and survey work in Northumberland has been restricted to the livestock rearing areas for one outstanding reason. At the present time, the shortage of meat, the high prices of imported wool and leather, and above all, the need for more stock to utilize the greater production from lowland farms, set a high priority on the production of store stock from the rearing districts on our hills and uplands.

AGRICULTURAL INDEX NUMBERS AND PRICES

MONTHLY INDEX NUMBERS AND PRICES OF AGRICULTURAL PRODUCTS

INCLUDING EXCHEQUER PAYMENTS (UNCORRECTED FOR SEASONAL VARIATION)

BASE 1927-29=100

	Unit	Prices used for Dec. Index 1952	1952			1951		
			Oct.	Nov.	Dec.	Oct.	Nov.	Dec.
All Products ..	—	—	291*	305*	312*	280	302	312
Cereals and Farm Crops	—	—	242	248	258	257	265	277
Livestock and L'stock Products	—	—	306*	323*	330*	288	315	324
		s. d.						
Wheat	cwt.	30 0	273	281	290	266	274	282
Barley	,,	30 0	273	270	273	380	382	394
Oats	,,	25 11	276	278	280	300	300	312
Potatoes	ton	236 6	210	220	235	200	210	225
Hay	—	—	183	191	198	233	236	237
Fat cattle ..	Live cwt.	118 11	235	231	241	217	214	230
Fat cows ..	,,	63 10	191	180	182	189	181	188
Fat sheep ..	lb. d.w.	2 4½	216	216	224	204	204	218
Fat ewes	,,	1 6	212	215	218	197	197	215
Bacon pigs ..	Score	55 3*	362	362	362*	346	346	349
Pork pigs ..	(20 lb.)	50 6	299	299	299	296	296	298
Sows	d.w.	27 5	238	238	238	235	235	238
Milk	Gallon	4 0.9*	338*	368*	376*	315	358	366
Butter	12 lb.	36 0	168	171	171	143	143	143
Poultry	—	—	248	255	276	266	281	327
Eggs	120	60 10	319	335	335	300	330	330
		£ s. d.						
Store Stock†								
Dairy cows ..	Head	59 9 0	217	221	220	194	204	213
Store cattle ..	,,	36 4 0	256	254	249	216	215	210
Store sheep ..	,,	6 5 9	222	225	232	218	221	227
Store pigs ..	,,	8 14 0	459	452	462	378	365	372

* Provisional † Not included in general index

ECOLOGY IN THE RECLAMATION OF SALT FLOODED MARSHES

P. J. O. TRIST, B.A.
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From experience in East Suffolk Mr. Trist records how some understanding of plant ecology can be most useful and of economic importance in reclamation work. Since this article was written, the reclaimed marshes referred to in this article, together with many thousands of acres along the East Suffolk coast, have been inundated by the sea from the disastrous tide of January 31—February 1.

AS a defence measure in 1940, 500 acres of marshland in the Minsmere Level on the Suffolk coast were flooded. The Minsmere Sluice was opened to all tides for a fortnight, until the land was under three feet of salt water. The sluice was then closed to prevent any further exit of fresh water or entry of salt water. The latter gradually mixed with the fresh water until the whole of the marshes to the north of the New Cut were inundated with salt water. In June 1945, the sluice gates were restored to normal operations and the flood was gradually released as the sluice gates opened at low tides, but because the marsh ditches were almost completely silted up, the flow off was slow and not very effective. In the spring of 1949, after the land, which had been used as a battle training area, was given back and cleared of explosives, it was agreed that 380 acres should remain derelict as a nature reserve, whilst the remaining 120 acres should be reclaimed.

The agriculturist has the advantage of laboratory tests for soil analyses, and whereas there is no doubt of their value, it is quite clear that the results of analyses for sodium chloride (NaCl) content should be used as a guide, in conjunction with the identification of flora, which continues to change with alterations in soil conditions. As an example of this work, a study was made on marsh O.S. 819, in the parish of Leiston, which was formerly in grass, and which is still dominated by salt-tolerant flora after two attempts at reseeding to grass.

The most important factor in restoring land from saline conditions is effective drainage. This particular marsh lies in the lowest part of the level and moreover has three distinct levels of its own—the average level, low areas and depressions below the average, and two ridges of high ground which varied from about 6 to 14 inches above the average level. It was this fact that created problem, interest and lesson.

In June 1949, three months after a start had been made on the excavation of ditches and four years after the salt water had been released, the marsh was freed of surface water, but it remained very wet. Two-thirds of the area was covered with common reed (*Phragmites communis*), and the remainder with wood club rush (*Scirpus sylvaticus*) and sea club rush (*Scirpus maritimus*). Some plants of mare's-tail (*Hippuris vulgaris*) and a few seedlings of fat-hen (*Chenopodium album*) were found on higher ground near a ditch. The first 6 inches of soil was a black, organic, silty, clay-loam, and from 6 to 24 inches it was grey and brown of a similar texture. Water was found at 24 inches. The *p*H was 7.5 and there was 0.45 per cent sodium chloride on the average level and 0.32 per cent on the higher ground.

The First Cultivation The marsh was used for pilot work and cultivations were started in July 1949, on the wrong assumption that salt levels would have fallen to a safe point for reseeding in 1950. Cultivations were carried on until early autumn, but because of heavy rains during the winter, the sea sluice was unable to discharge properly and this marsh was flooded off and on until April 1950. By June the land was again covered with reed and rush, whilst a soil sample from the average level showed a fall in sodium chloride to 0.32 per cent. Cultivations proceeded and the marsh was seeded to grass in the autumn of 1950. On October 20, a fortnight after drilling, there was a good take on the average and higher levels, but there was no clover. In the depressions, germination was poor and unthrifty. As time went on, no clover appeared and the ryegrass and timothy stood still. In early November, a soil analysis established the reason for the standstill: on the average level the sodium chloride had risen to 0.48 per cent. On the high ground the sodium chloride was 0.35 per cent, although both grass and clover were flourishing.

The marsh was again flooded in the winter of 1950–51, and soil samples taken on May 20, 1951 showed the first effect of fresh-water flooding, namely, a fall in the sodium chloride content. The actual figures recorded then were:

	percentage NaCl
High ground at 6 inches	0.12
„ „ at 12 „	0.13
Average level at 6 „	0.17
„ „ at 12 „	0.25

In May 1951, grasses and clovers on the high ground were still flourishing, whilst on the average level only perennial ryegrass remained. Both the average level and the depressions had been invaded with marsh foxtail (*Alopecurus geniculatus*), and most of the low areas were fairly thickly covered with water buttercup (*Ranunculus aquatilis*); however, as soon as the marsh was dry (in May) the latter disappeared. Having seen a considerable fall in the salt level in the first 6 inches of soil, we again made the mistake of assuming that conditions were now safer for a second seeding attempt than they had been at first. Cultivations were carried out again and another mixture was sown.

It is clear that there is a great deal of difference in the effects on salinity of a quick flush of fresh water and constant flooding. The latter may reduce some salt in the surface soil, but the waterlogging causes salt to rise from lower down, and this accumulates at the surface in the warm weather.

Up to this date, the marsh had provided only two changes in flora. The first was a reversion to *Scirpus sylvaticus*, *Scirpus maritimus* and *Phragmites communis*, and the second was the appearance of *Alopecurus geniculatus* and *Ranunculus aquatilis* with the remaining sown plants of *Lolium perenne*.

The Marsh is Seeded Again The second seeding took place on July 2, 1951, and in the second week of July there was exceptionally heavy rain for several days, followed by a warm spell. The original seeding on the high ground was firmly established, but once again the seedlings on the average level of the marsh did not appear to be thriving. By mid-September, when the plants had had time to grow, the marsh was examined and the following were found:

Aster tripolium	Sea aster
Spergularia salina	Sea spurry
Rumex maritimus	Golden dock
Scirpus maritimus	Sea club rush
Scirpus sylvaticus	Wood club rush
Atriplex hastata	Hastate orache
Atriplex patula	Common orache
Chenopodium rubrum	Red goosefoot
Phragmites communis	Common reed
Polygonum aviculare	Knotgrass
Sonchus palustris	Marsh sow thistle
Alopecurus geniculatus	Marsh foxtail
Lolium perenne	Perennial ryegrass

The majority of the species listed above are fairly tolerant or highly tolerant of salinity. It was their presence which indicated soil conditions, and without any further soil analysis it was clear that the salt level had risen considerably above 0.17 per cent. In the depression levels there were no grasses other than *Alopecurus geniculatus*, and all flora were spaced with considerable areas of bare ground thickly covered with white crystals of salt. In the lowest places, this scum was accompanied by a growth of dark red and green algae, and an analysis of the top inch of this soil showed 1.54 per cent sodium chloride. Further samples taken on November 2 gave the following results:

	percentage NaCl
High ground at 6 inches	0.12
„ „ at 12 „	0.14
Average level at 6 „	0.39
„ „ at 12 „	0.30

It will be seen from these figures that, whereas on the high ground the sodium chloride content remained the same as in the previous March, on the average level of the marsh it had risen from 0.17 to 0.39 per cent in seven months. But even before taking soil samples, it was clear from a study of the salt-tolerant flora that soil conditions had altered considerably and favoured certain flora that would not be found in the company of a marsh sward.

Whilst other marshes on the level have been successfully reseeded, this marsh and two of its neighbours still remain bare of grass, except where there is natural drainage from higher ground. The same flora as recorded in the autumn of 1951 was present in June 1952, but in greater quantity. The sodium chloride content in June was 0.4 per cent and 0.51 per cent on a neighbouring marsh on which a fair quantity of spike rush (*Eleocharis uniglumis*) was growing. It is not proposed to do any further cultivations until more permanent work has been carried out on the Minsmere Sluice to prevent further winter fresh-water flooding in this part of the level. It is clear that continuous flooding during the winter causes a rise of salt after a spell of warm weather, and as long as these salt-tolerant plants continue to thrive, there will be no need to have further soil analysis for sodium chloride to assess whether the time is ripe for another attempt at reseeding to grass. Incidentally, the grasses and clovers used in the two mixtures have been successfully established on other reseeded marshes on the level, so the failures in this instance therefore have no relation to the grasses and clovers selected.

THE HOUSING OF PIGS

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Warmth is fundamental to the well-being of pigs, and modern housing, whether related to the open-air or indoor systems, should be designed to that end.

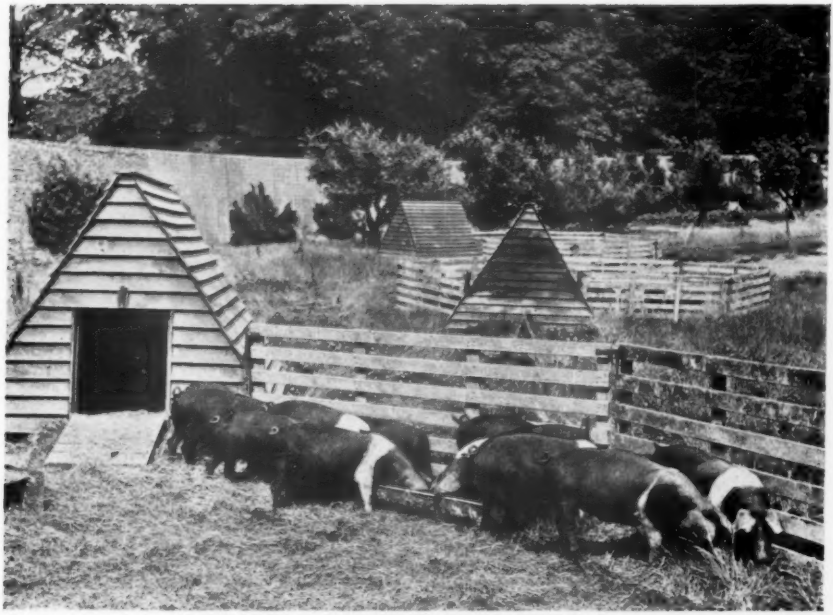
THE housing of pigs, like the housing of other farm animals, is in essence the product of a compromise between the needs of the animal and the needs of the man who exploits it. Housing is merely one of the means whereby man enables the pig to reach a higher level of productivity than is possible in nature. Human convenience and profit are the incentives behind pig housing. But the pig-keeper, while applying his commercial standards to the design and construction of his piggery, should always, in his own interest, put the basic needs of the pigs first, for it is on their welfare and efficiency that the success of his enterprise depends.

Basic Needs of the Pig The pig is a peculiar animal and its requirements differ considerably from those of other farm animals. Being almost hairless, it is particularly susceptible to changes of temperature, to draughts, and to extremes of heat and cold. Its ancient home, therefore, was forest and scrubland, not open country. Grassland might suit cattle and sheep : it did not suit the pig, which sought warmth and a dry bed in nests and burrows which it made for itself amid the undergrowth of the old woodlands. Moreover, the nature of these primitive shelters explains one of the most marked characteristics of the pig which, as an animal of cleanly habits living in a confined space, developed the habit of dunging and urinating away from its sleeping-quarters. The modern designer of pig buildings does well to remember the hints which the wild pig has given him about the requirements of its domesticated descendants.

It is clear from practice and experiment, as well as from history, that the first function of a good piggery is to provide a warm, dry bed. It is equally clear that the pig-keeper can help to secure this by making use of the habits of the pig ; the more the pig deposits its excreta away from its sleeping-quarters, the warmer and drier its bed will be. What may be the right temperature for the housed pig is a difficult question ; but the following conclusions summarize the available evidence :

1. The temperature of a piggery for pigs beyond the weaning stage should never be allowed to fall below 50°F. It should be above this figure for the proper progress of the pig. Probably 60°–65°F. is a reasonable temperature at which to aim.
2. Very young pigs, i.e., from birth to three or four weeks' old, require a higher temperature than older pigs. The temperature of farrowing pens should not be allowed to fall below 65°F. and should perhaps be as high as 75°, or even 80°F.
3. The maintenance of a constant temperature is highly important.

These figures do not necessarily apply to pigs kept in the open air, where they are exposed to varying temperatures which keep their heat-regulating mechanisms stimulated.



An open-air system, using movable huts and pens

Photos : *Farmer and Stock-breeder*

The simplest method of housing pigs is in yards

Photo: *Commercial Camera Craft*

Mucking out the dunging-passage of a Scandinavian type piggery

Photo : *Horace Hall*

Interior of modern well insulated house at Harper Adams Agricultural College

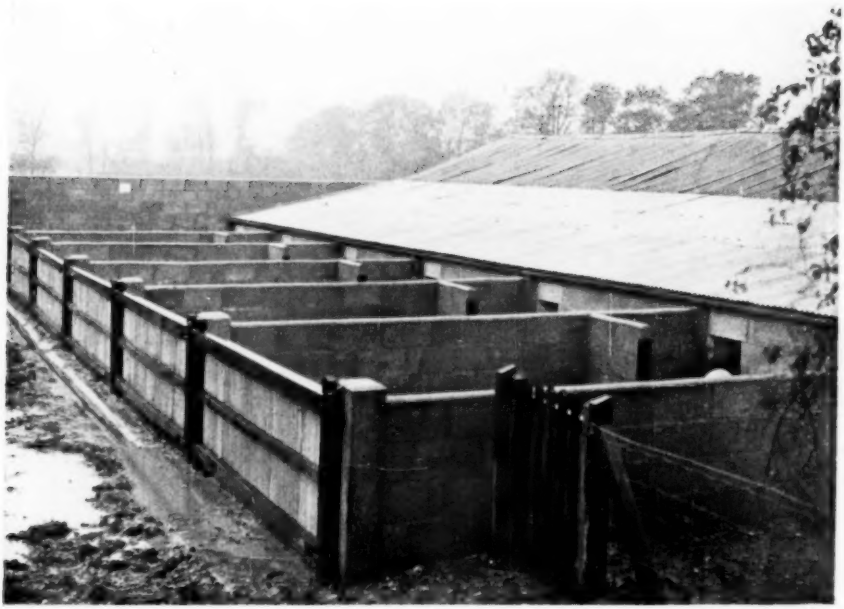


Photo : *Horace Hall*

Outside view of the piggery at Harper Adams Agricultural College

A warm kennel-cum-creep for piglets

These basic needs of warmth and dryness can be met in a startling variety of ways, and "pig housing" is a subject as large as, say, " milk-production buildings". Much will depend on the particular circumstances of the farmer whose choice of housing system will, in turn, be guided by such factors as the size and permanence of his pig enterprise, the type of pig to be produced, and the land and crops available. If it is a matter of long-term policy and large-scale production, a new specialized house may be needed. But if pig-keeping is to be on a small scale, as a side-line or as a temporary expedient, the conversion of an existing building or the construction of a simple new one may be preferable. There is no standard answer to the question, " what is the best way of keeping pigs ?", for it raises many other questions which the individual farmer must answer before he can choose the method likely to suit him best.

Open-air Systems The first choice lies between open-air and indoors. The open-air systems are suitable in areas of mild climate and well-drained land. In principle, the pigs are kept in large enclosures out-of-doors and provided with simple buildings for shelter and sleep. These enclosures, however, soon become muddy and infested with parasites, so that sufficient land is required to provide for the rotational movement of the pigs. This implies buildings which are either portable or temporary ; on the one hand, huts or arks mounted on skids or on wheels, on the other, shelters made from straw bales and other ephemeral materials.

Open-air systems are suitable for all types of pigs, excluding fatteners which, except during the summer months, convert an excessive proportion of their food into warmth and movement and not into meat. They are particularly suitable for young pigs and breeding stock, since fresh air, exercise and sunlight do much to ensure that the young pigs get a good start with a strong body-frame in preparation for fattening or breeding. As the litters are isolated, the spread of the various diseases, such as influenza, to which young pigs are so prone, is automatically controlled.

Indeed, the main advantage of these systems is the healthy conditions they provide. In particular, it is claimed that these open-air systems decrease the risk of anaemia by allowing direct access to minerals in the soil. Further, the folding of pigs on leys suits modern systems of farming and improves the fertility of the land without the labour of muck-carting. On the other hand, the labour involved in looking after pigs in a number of scattered buildings tends to be higher than if the pigs are kept in one building, although this may be reduced by careful arrangement of the enclosures and the provision of a piped water supply. In bad weather, too, conditions are often unpleasant and laborious for the pigman, as well as uncomfortable for the pigs.

Temporary buildings can generally be improvized, and portable buildings are cheap to buy, though the cost of their maintenance or replacement is relatively higher than that of permanent buildings.

Yarding of Pigs Indoor housing, though necessary in many parts of this country, is both more complicated and more expensive. The simplest method of housing pigs is in yards, either covered or partly covered, which provide many of the advantages of outdoor systems without some of their disadvantages. Yarding is suitable for all types of older pigs, though it is most common with fattening stock since they can be kept together in larger lots than breeding stock. This avoids the need of dividing yards into smaller enclosures. Loose boxes can also be used, either with

yards or by themselves. In both types of building, however, ample supplies of straw are necessary, otherwise the pigs are unable to keep warm.

This system generally needs little capital expenditure and involves no special-purpose buildings. Many farms already have yards that need little adaptation to make them suitable for pigs and, if circumstances alter, could easily be restored for other forms of livestock. Indeed, it is not uncommon to house pigs and bullocks in the same yard. The routine of feeding and weighing yarded pigs, however, requires particularly careful planning, otherwise the labour demands of this type of housing may be excessive. In some instances labour may be reduced by the provision of a communal feeding place.

Fattening Houses Chronologically, the first modern type of fattening house was the familiar "Scandinavian" piggery which appeared over here after the First World War. This met both the needs of the pig by providing a pen for sleeping and a passage for dunging and the needs of the pigman by providing a convenient layout for feeding and mucking-out. But it was a fairly expensive type of house to build, it allowed the pigs no access to the open air and also generally failed to keep them warm enough. For the "Scandinavian" houses erected in this country seldom incorporated the heat-conserving, insulated walls and overhead lofts of their foreign originals. It would, indeed, be more accurate to call them "Anglo-Scandinavian" houses, since they were not copies but adaptations of the true Scandinavian designs. In these British houses, then, the forces of heat conservation commonly fought a losing battle with the forces of cold, and the satisfactory Anglo-Scandinavian piggery was the exception rather than the rule. This weakness could, of course, be overcome by proper construction, but the revival of the pig industry since the war has not seen any general revival of this type of house. Modern designers have tended to start from scratch rather than improve the Anglo-Scandinavian house.

Recent years have seen the development of a confusing variety of fattening houses. But it is possible to distinguish two main schools of thought among their designers. Both continue the sound Anglo-Scandinavian principle of providing separate areas for dunging and for sleeping. Both, too, appreciate the importance of warmth for the pigs' welfare, and both seek to conserve the natural heat of the animals. But they differ in their methods of retaining this heat. One relies mainly on the insulating properties of deep straw litter in which the pigs can make nests for themselves, the other on insulated forms of construction. Each of these two basic types can be subdivided into certain more detailed categories and, of course, various permutations and combinations of design are found in practice. But the means whereby the natural warmth of the pig is conserved is a useful and obvious "line of demarcation" between them.

The deep straw piggery endeavours to provide the pigs with the equivalent of natural conditions, as the pigs can lie on the straw or bury themselves in it according to their requirements. It is economical of labour since the muck is cleared only every month or so, depending on the particular design of the house, and it preserves all dung and urine, mixed with straw, as good manure. But, of course, it is necessarily confined to farms and areas where adequate straw is available. Examples of two familiar types of deep straw piggery are the "Reid" and "Black" houses, both called after their originators.

The basic pattern of the modern heavily insulated house was first developed by the famous Mr. McGuckian of Northern Ireland, though a cheaper version recently built at Harper Adams Agricultural College will probably

be more familiar to English pig-farmers. In design, this house continues the tradition of the cottager's pigsty, providing an open run for dunging and urinating and an enclosed pen for shelter ; but this pen, unlike the pens of the older sties, is well insulated, and the door to the run is fitted with baffles, generally accompanied by screens, to prevent loss of heat.

The detailed comparison between the deep straw and the insulated types of fattening house is, unfortunately, more than difficult. It is not hard to calculate the capital cost of any particular form of construction, but the assessment of the running costs of each type of house in terms of labour requirement or of its performance in terms of pig output is a very different matter. Here, as elsewhere, however, the best type is the one which suits the methods and needs of the individual farmer best.

Farrowing Accommodation Farrowing accommodation protects the pig at the weakest, and therefore the most dangerous, stage of its life—namely, when it is new-born. Sows may farrow in shelters or portable huts which form part of an open-air system, or in indoor farrowing accommodation which may be a box, a sty, a small pen, or a specialized building. Where all-the-year-round farrowing is contemplated, indoor accommodation is preferable. For one thing, piglets are peculiarly susceptible to cold, and the control of temperature is easier in permanent buildings than in portable or temporary structures. For another, pigs born in the farmstead tend to get better attention than those housed in distant fields.

There are many possible forms of farrowing accommodation, but all should provide sufficient room for the pigman at farrowing time as well as the pig ; it is a dangerous as well as an unpleasant experience to be shut up with a nervous sow in a pen too small to allow free movement. They should also provide protection against the various dangers which take such a heavy toll of young pigs, notably cold and crushing by the sow. These two factors are indeed connected, for the majority of losses are due, it seems, to the piglets snuggling close to their mother for warmth and so getting into a position where she can carelessly lie on them.

Such familiar devices as farrowing rails and creeps provide protection against crushing, while nests give both protection and warmth. A more recent development is the artificially heated " warm zone " which has the double advantage of giving good environmental conditions and attracting the piglets to a place of safety. These " warm zones " can be heated either by overhead electric heaters or by electric floor-warming units. An ingenious combination of nest, artificial heating and specially designed floor was exhibited by the Ministry of Agriculture at the 1952 Bath and West Show. This was the Kentucky Sloping Farrowing Floor, so called from its place of origin. Tests in America on 385 litters showed that sows farrowed on sloping floors lost only 3½ per cent of their piglets by crushing, whereas those farrowed on level floors lost nearly 25 per cent from the same cause.

No short article can do more than review the more obvious modern developments in pig housing and it cannot begin to deal with such detailed but essential questions as measurements, ventilation and methods of insulation. But the whole subject will be discussed fully in a new bulletin which the Ministry hopes to publish this year.

hybrids with a better standing ability, higher ear placement and a suitability for mechanical harvesting can be produced for regions where maize grain crops were formerly considered uneconomic. All the commercially available American and Canadian hybrids have been tested at Oxford in recent years, but all of them are too late to ripen grain *consistently* in the southern half of England.

The experiments have confirmed the high potential level of production which maize possesses. On a plot scale, yields as high as 50 cwt. of grain per acre have been recorded under a combination of favourable soil, site and season, while over a number of trials the best of these American hybrids have averaged 38 cwt. per acre, as against 25 cwt. for open-pollinated flint varieties.

To translate plot yields to field yields may require a considerable scaling down but, even so, from the point of view of grain production maize compares favourably with the more usual cereal crops. A high yield is not enough, however, if harvesting is difficult and expensive. Recently, a number of earlier-maturing experimental hybrids from North America and Holland have been tried out at Oxford, but, in spite of the extra earliness, the grain moisture content at harvest in 1952 was 39 per cent. Such a figure is not out of line with those which have been obtained in the more continental climates of Holland and northern France. Ears containing so much water are extremely difficult to thresh, even with the most efficient equipment ; the product contains many split grains and, on occasion, has the consistency of porridge. There is no need to emphasize that the product must be dried at once, and the drying of such wet material presents many difficulties. Moreover, to reduce the moisture level from 40 to 12–15 per cent is costly.

The alternative approach is to let the ears dry out naturally before attempting to thresh. The usual practice is first to remove the ensheathing husks either by machinery or by hand, and then to place the ears in a crib, which in essence consists of four posts set in the ground at the corners of a narrow rectangle, the whole being surrounded by wire netting or wooden laths, and a protective roof with a generous overhang being placed on top. Preliminary attempts were made to discover whether ears would dry not successfully without resorting to the expensive process of husking ; but with high autumn humidity the cobs lost water slowly and there was much spoilage by fungus. Further trials are now being started using husked ears and the very narrow cribs recommended in Holland.

Clearly, before large-scale cultivation can be rationally contemplated, more information is required on the techniques of harvesting, threshing and drying, and how far the mechanization of the crop can be achieved with imported machinery without further modification or radical re-design. Meantime, there is a possibility that smallholders can harvest the crop as required and feed the husked ear direct. In this connection, it is perhaps not without significance that much of the maize acreage in Holland is grown by farmers sowing less than 4 acres.

Earliness It has been suggested that the need for increased earliness might be met in part by sowing earlier than May. Unfortunately, the hybrids and open-pollinated varieties so far tested are insufficiently tolerant of the cold to survive early sowings. During the past decade there has been intensive research in America on the factors involved, and similar studies were first taken up in this country at the John Innes Horticultural Institution

in relation to sweet corn and, soon after, at Oxford, with maize. So far the indications are that the ability to resist fungus attack in the germinating phase rather than the ability to grow at low temperatures is the main variable, and the results to date do not justify any modification of the recommended sowing time. Every advantage should be taken of natural or local conditions favouring higher soil temperatures at sowing time : thus well-drained and fertile light loams combined with a southern aspect are the best. In Holland, maize is grown principally on the fertile, sandy soils of the Southern Province, and it is probable that the warmer soil in early spring and a readily available supply of water contribute more than the higher summer air temperatures to the slight but very important increase in earliness as compared with this country.

American experience indicates that where the environment is on the border line for successful grain production it is essential, for really satisfactory results, to develop hybrids to suit the local conditions, rather than to rely on introductions.

Difficulty of Maintaining Stock Seed Since some 22–28 lb. of hybrid seed is required per acre, and since the use of second generation seed of a double-cross hybrid will cause a loss in yield of about 20 per cent, a large-scale organization is needed to produce new hybrid seed every year ; and that involves the maintenance of inbred lines, the production of single-cross hybrids and the further production of double-cross hybrid seed for commercial planting.

As inbred lines are invariably later in maturity than the hybrids they produce, the maintenance on a large scale of essential inlines may be economically impracticable. For example, although in 1948 the production of final double hybrid seed of the two early Wisconsin hybrids (W.240 and W.255) was achieved fairly satisfactorily, it has not been found possible to maintain the inbred lines or to produce the foundation single-cross hybrids economically. The solution to this problem may well be that at least the maintenance of inlines and the production of the single crosses will have to be undertaken abroad in a warmer environment. If so, the closest collaboration will be needed between the plant breeder and the seed trade.

A possible alternative approach to double-cross hybrids is the development of "synthetic" varieties. A synthetic variety is a multi-cross hybrid from more than four inlines, which, although it cannot be expected to yield as much as a double-cross hybrid, can be maintained in the same way as an open-pollinated variety. This development would greatly simplify the production of stock seed. Work along these lines is now in progress at Oxford, but the breeding of synthetic hybrids, like that of hybrids, is a slow process. Since similar research is being undertaken on the Continent, progress may be accelerated by the exchange of material and information. It is as well, however, to remember that it took nearly twenty years for the American developments to come to a head.

For silage purposes, maize is fit to cut when the ear is half-ripe, and so it can be grown beyond the areas regarded as suitable for grain production. In consequence, the difficulty of suitable early varieties does not arise. However, as a maximum production of about 4 tons of dry matter per acre is obtained only with varieties of later maturity than the grain types, the breeding and development of silage hybrids would be impossible in this country. Accordingly, an annual introduction of hybrid seed from the Continent or elsewhere would be required.

HYBRID MAIZE AS A GRAIN CROP

If maize, either as a grain or silage crop, is to find a stable place in British agriculture, there is another urgent problem needing solution ; that is, some new and effective way of dealing with rooks which, at present, constitute more of a menace to maize growing than the British climate.

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THE USES OF SAWDUST IN HORTICULTURE

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Sawdust composted and in the form of mulches offers the horticulturist a cheap and effective substitute for straw.

AN increasing interest is now being shown, both in this country and abroad, in sawdust as a source of organic matter for use in soil improvement. It is, in fact, being used much more in the United States, Canada and Australia than in Great Britain, and it is in these countries that most of the experimental work has been carried out. Here, we have relied for our information on its value mainly upon the observations made by practical growers, and it is not surprising, therefore, that there are considerable differences in the reports available. It may be that these conflicting views have prejudiced growers against the use of sawdust : certainly, there are many who would not use it under any circumstances. The shortage of animal manures and the high prices of efficient substitutes has, however, driven many growers to explore the possibilities of waste products that are still cheap and plentiful. Straw is a good example of one such substitute which has been tried out, and straw mulching and composting has come to stay. Nevertheless, straw is not cheap and compost-making with it is an expensive business so that there is still a real need for a substitute that is readily available at an economic price. In theory, sawdust is the perfect substitute. Readily available, usually without cost, it is clean and easy, though not cheap, to handle. It can be stored for long periods and, indeed, is improved by so doing. All that is needed to ensure its greater use is to break down what is really an unjustifiable prejudice against it.

Sawdust as a Fertilizer As a fertilizer, sawdust is of practically no value. Its composition varies with the type, age and degree of rotting of the wood from which it comes. Turk (1) has calculated that fresh sawdust contains, on the average, about 4 lb. nitrogen, 2 lb. phosphoric acid and 4 lb. potash per ton of air-dry material. This is less than one-third of the total plant food in wheat straw. Not only is the supply of plant nutrients low, but its availability is delayed. In his view, the benefits to be derived by mixing sawdust with soils or using it as a mulch are largely

physical. It will loosen heavy soils by improving their structure and aeration and increase the water-holding capacity of sandy soils. As a mulch, it will protect the moist soil from the direct rays of the sun and from direct contact with wind and warm, dry air. It may also reduce the cracking of the soil surface and prevent lifting of plants by frost. The mulch may bring about an increased absorption of water by reducing the surface run-off, and prevent clogging and crusting of the surface soil under the impact of rain.

Has Sawdust Poisonous Properties ? A number of loose statements have been made from time to time that sawdust, and especially that derived from coniferous wood, is toxic to plants. From work done in America and elsewhere, however, it would seem that these statements are unfounded, and any unfavourable reaction on crops that follows the use of fresh sawdust, coniferous or otherwise, is certainly not due to poisonous substances. Any depression in growth is brought about almost entirely by a lack of nitrogen in the soil, though where sawdust has been derived from one particular species of wood, the *p*H of the soil may be lowered temporarily by the sawdust and so have a consequential depressing effect on the crop concerned.

McCool [2] has investigated the *p*H values of a number of types of sawdust, and the table of values he has prepared shows just how much these vary. Thus cypress, which is the lowest he records, has a *p*H value of 3.5, while hemlock spruce, the highest, has a *p*H of 6.8. Very heavy dressings of sawdust from a species having a very low *p*H could temporarily affect crop growth, and this may be another reason for the depression which sometimes follows heavy dressings. In this country, sawdust is usually mixed so that the *p*H varies from 5 to 5.5, and there is no evidence that normal dressings of this nature materially affect the *p*H of soils. In any case, the effect would be only temporary. As further evidence of this, Boller and Stephenson [3] have reported that whereas sawdust mulches had not changed the degree of acidity of the underlying soil at the end of eighteen months, the use of straw and walnut leaf mulches in similar circumstances has resulted in a decrease in acidity.

Should Sawdust be Dug into the Soil ? Although, in Britain, sawdust has been used mainly for mulching purposes, some growers have been ploughing or discing it into their soil for many years. Generally, however, with the exception of a few crops such as beans, peas, and rhododendrons, unfavourable or even disastrous results have followed the working-in of fresh sawdust. Turk suggests that the failures are due to a decrease in nitrates brought about through the increase in their assimilation by micro-organisms. The carbohydrate material contained in the sawdust supplies the micro-organisms with food and energy which increases their demand for available nitrogen. He gives details of pot experiments with barley which show that sawdust, when mixed with soil, has no depressing effect provided sufficient nitrogen is available. In his view, sawdust can be worked into soils without fear of harmful results, provided it is supplemented by some readily available source of nitrogen. In the absence of official trials in this country, it is difficult to contradict these results, but the experience of most growers here is that fresh sawdust depresses the following crop even where nitrogen is given. Only in the case of some shrubs and the leguminous crops does it seem safe to use fresh sawdust in this way. Those of us who have used sawdust over a period of years prefer to work with material that is three or four years' old, or with

that which has been composted. If fresh sawdust must be used, its use should be restricted to the crops mentioned above, and nitrogen should be added. With a dressing of 2 inches of dry, fresh sawdust (35 tons per acre), 20 cwt. sulphate of ammonia would be sufficient on reasonably fertile soils. Even with rotted sawdust, some nitrogen is beneficial and will prevent any depression in growth in the first year.

Composted sawdust, however, is ideal for working into the soil. It does not require supplementing with nitrogen and it gives excellent results with a wide range of crops. Indeed, there is hardly any crop which will not benefit by dressings of well-made sawdust compost. The best way of making the compost is to mix sawdust with animal or poultry manure in the proportion (by quantity) of three lots of sawdust to one of manure, and then leave it in heaps for some months. If the sawdust is very dry, it should be wetted thoroughly whilst it is being mixed. It need not be turned and provides an easy way of using fresh poultry droppings—a difficult and unpleasant material to use as a manure in any other form. Where poultry or animal manure is not available, "Nitro-Chalk" may be used as an activator at the rate of 1 cwt. per ton of sawdust. Sawdust is slow to decompose because of the action of antibiotics and also because of the acidity which may inhibit the growth of cellulose-decomposing bacteria(4). In view of the desirability of using rotted rather than fresh material, it is not surprising that work is being carried out to find means of decomposing *it* more speedily. Some results have been obtained with sawdust heated with acid, but anything which adds to the cost should be carefully considered ; the chief virtue of sawdust is its cheapness.

Use as a Mulch Many growers and research workers testify to the value of sawdust mulches. In experiments in British Columbia, Harris (5) says : " Yields of strawberries were substantially increased the second year after application, and while there was a reduction in the sugar content of the fruit there was an increase in vitamin C content". Dealing with the same subject, White (6) reports that : " Practically all small fruit plantings are now mulched with sawdust. The results to date are excellent and no detrimental effects have been observed. The ease with which young strawberry plants were dug this spring on the mulched area was very noticeable. Growth of young plants was excellent". Several workers in British Columbia remark on the effect of sawdust mulches in preventing plants heaving during severe frosts, and suggest that the markedly heavier yields following the use of sawdust may be due to this.

Shutah, Christopher and McElroy (7) state that sawdust-mulched blueberries produced higher yields than those under straw mulch, clean cultivation plus cover crop, or clean cultivation throughout.

In this country, Roach and Forshaw conducted trials in 1950 and 1951 in south-west England to compare unmulched blackcurrant bushes with those mulched with straw and with sawdust. Better leaf and growth development was evident in both years on the mulched bushes. There was, however, little evidence of any difference in the behaviour of the bushes, as between the straw and the sawdust mulches. Under these conditions, it appeared that straw was rather more effective than sawdust in suppressing weed growth. Roach and Forshaw also make the point that, while sawdust can be obtained very cheaply, the labour costs incurred in its transport and application in the field are rather high.

One of the less favourable features of sawdust mulching is its cumulative effect on the nitrogen uptake. Johnson (8) found that sawdust, when applied

as a mulch, depressed the nitrate content less the first year than in successive years. Roach has reported that a blackcurrant grower in Dorset had a good response from his bushes the first year after a very heavy mulch of sawdust had been applied, without adding any nitrogen. The following year, however, acute nitrogen deficiency was apparent, and this has been very difficult to correct in spite of subsequent heavy dressings of nitrogen applied on top of the mulch. Similar effects have been reported by Roach where cordon apples were mulched with sawdust without the addition of a nitrogenous fertilizer.

From the experience of growers generally, it would seem to be better to work in the mulch at the end of the year. When mixed with the soil, some of the nitrogen taken up is recovered. Excellent crops of potatoes and strawberries are reported from a turned-in one-year mulch, and some producers of strawberry runners claim to get quicker and better rooting following the discing in of a sawdust mulch. Others mulch the rows just after planting to keep weeds down prior to the formation of runners. When runner production starts, the mulch is sufficiently rotted to make an excellent rooting medium. Growers of flowers such as pyrethrums also report good results, and some claim that slugs—always a problem with this crop—cause appreciably less trouble.

Sawdust is used a good deal for the mulching of soft fruit, keeping down annual weeds in the early stages and, eventually, supplying the well-rotted humus so much appreciated by soft fruits. If well-rotted sawdust can be obtained this is ideal. One has only to observe the growths made by brambles on heaps of decaying sawdust near country sawmills to realize how much a mulch of this material can help such fruits as blackberries, loganberries and, to a less extent, raspberries. When using fresh material, it would appear best to put on thin layers, never more than 2 inches deep, so that the call on nitrogen by the soil bacteria is restricted. Even with this precaution, it is best to add up to 20 cwt. sulphate of ammonia per acre unless the nitrogen content of the soil is very high. It is important to apply the nitrogen to the soil before putting on the mulch.

A few growers in the west have tried one-inch thick sawdust mulches, impregnated with 10 per cent wettable DDT at the rate of 4 lb. to each hundredweight of sawdust for the control of the Large Narcissus fly. But the results have not been consistent and at present no general recommendations can be made.

It has been reported by some growers that a light dusting of sawdust over sowings of lettuce reduces attack by *Botrytis*. Others say that slug damage is much less on fruiting strawberries where a sawdust mulch impregnated with metaldehyde has been given.

Sawdust as a Bedding Material Years ago it was almost impossible to sell manure from stalls where sawdust had been used for bedding, but there is no real reason for any prejudice in its use. Midgley (9) suggests that sawdust and shavings compare favourably as bedding materials with straw and hay. Their subsequent use as a fertilizer may, however, result in a temporary reduction in plant growth if used in large quantities or with manure low in nitrogen. Perhaps the best use of sawdust as a bedding material is in poultry-houses. Poultry manure is approximately three times as rich in nitrogen as cow manure, and the nitrogen is more quickly available. Mixed with sawdust and roughly composted in the poultry-house, it forms an extremely good fertilizer for many crops. One rhubarb grower says that he can pull rhubarb throughout the summer

from beds treated with sawdust litter obtained from poultry-houses. Other growers report exceptional yields of strawberries and raspberries, and with flower crops the combination of nitrogen and humus increases the length of stems and intensifies the colours.

Summary Summing up, it has been shown that the prejudice against sawdust is unjustified, and provided that the material is properly used, it has considerable value as a soil mulch and improver. Because of its low nitrogen content and slow rate of decomposition, the addition of readily available nitrogen is essential, and the material is best applied as composted sawdust or as well rotted material from old heaps. Composting with fresh poultry droppings is particularly convenient. Fresh sawdust is best avoided with most crops, but if used will need at least ½ cwt. sulphate of ammonia per ton, and it should be used purely as a mulch and on no account dug into the soil before the end of the first season after application.

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GRASS ESTABLISHMENT ON POWER STATION WASTE

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and
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A two-year experiment conducted at Hams Hall Power Station, near Coleshill, Warwickshire, indicates that after suitable treatment ash tips can be made to produce a useful grass ley.

IN all parts of the country vast quantities of waste pulverized fuel are being produced, and since so far this has no economical commercial use, its satisfactory disposal is presenting a problem. The "A" Station at Hams Hall alone yields some thousand tons weekly which, over many years, has been tipped into nearby low-lying meadow land. It now occupies an area of approximately 40 acres, raised about 40 feet above the original ground level. This waste, unlike many industrial spoils, does not quickly become colonized by weeds and, as the bulk of it is composed of

very fine particles, it gives rise, on drying, to clouds of dust. The objects of ley establishment, therefore, may be regarded as threefold : to stabilize ash, to reclaim for agriculture areas of otherwise useless material and to camouflage their drab appearance. The medium used in these trials to get establishment was another waste material—sewage sludge. Two varieties of sludge were used—a domestic variety and an industrial form.

The experiments were conducted on the bulldozed flat summit of the ash tip over an area of about 1½ acres. The sewage was spread on top of the ash in two thicknesses—3 inches and 12 inches—and in some places an additional layer of 3 inches of soil was placed on top of the sludge. This soil was composed largely of waste subsoil from an excavation near the station : in all, ten treatments as shown in Table 1.

Table 1

List of Treatments Employed

	Abbreviation	Composition
1.	*Nil*	*Ash*
2.	S	3 inches of soil
3.	3C	3 " Domestic sludge
4.	12C	12 " " "
5.	3C+S	3 " " " and 3 inches of soil
6.	12C+S	12 " " " and 3 inches of soil
7.	3M	3 " Industrial sludge
8.	12M	12 " " "
9.	3M+S	3 " " " and 3 inches of soil
10.	12M+S	12 " " " and 3 inches of soil

The treatments were all on rectangular plots measuring 15 yards × 6 yards, ten such plots being arranged at random in each of five blocks. The whole area was afterwards surrounded by a rabbit-proof fence. The plots were allowed to weather until the following April when a dressing of National Compound Fertilizer No. 1 was given to all plots at the rate of 2 cwt. per acre. Tests showed that no lime was necessary ; indeed the pulverized fuel ash itself i.e., as seen on the Nil plots, was decidedly alkaline, whilst the lowest *p*H determined on the remainder was 6.6. in the case of the 3C plots.

The First Season Attempts were made to till the plots with an auto-cultivator in preparation for seeding. Dried sludge, however, does not lend itself to such treatment and the plots had to be hand-tilled by hoeing and raking. The following seed mixture was sown on May 23, 1951 :

	lb. per acre
Italian ryegrass	8
Cocksfoot S.143	14
Red fescue S.59	8
White clover S.100	3

The plots were afterwards raked and rolled.

By early July, a good growth of grass had appeared on many of the plots. The "C" plots appeared to be the best, whilst such cover as was present on the Nil treatments was confined to weeds. Cover on the M plots was very sparse, plants were yellow and root development was poor. Of the mixture sown, only ryegrass and clover were represented at this stage. These species were present on all except the Nil plots. Weeds were very prevalent on most treatments, and the whole fifty plots were cut with an autoscythe at a height of 4 inches to remove these aliens. The weight of this cutting was not recorded. The plots were subsequently cut in August and November

1951, and May, July and November 1952. On these five occasions the yields of each plot were weighed *in situ* and recorded as fresh weight. The grass so obtained was used by a local farmer as animal feed. The mean yields of the combined harvests are given in Table 2.

Table 2

Combined Yield of Five Harvests (tons per acre)

Treatment	Nil	S	3C	12C	3C+S	12C+S	3M	12M	3M+S	12M+S
Fresh weight	0.28	11.4	35.81	39.41	39.40	39.02	1.69	1.11	15.89	13.78

These data show how significantly higher yields were obtained with all domestic sludge treatments, while the industrial sludge gave much lower yields. The M plots produced negligible amounts in the first year ; moreover, much of the growth on pure industrial sludge was *Agrostis* (bent), a species which was not sown. The addition of soil to the industrial sewage does increase its yield, but this is still less than half that given by the domestic variety. Comparison between the S and Nil values indicates that the addition of such small amounts of soil as 3 inches increases its productive capacity about fortyfold.

In the first season, as was expected, Italian ryegrass was by far the most vigorous component of the leys, and by October 1951, it was the dominant species of the C and C + S plots, along with a fair amount of cocksfoot. Clover occurred only rarely on these treatments, but all the domestic sludge plots showed a luxuriant growth of grass 2 feet high. The ryegrass was fulfilling a similar role on M + S plots, along with cocksfoot, but here frequent clover was found, whilst the general height of the ryegrass was rather lower (about 12 inches). The S plots at this stage were characterized by a high population of clover, which was locally dominant in places with frequent ryegrass and cocksfoot about 6 inches high. Fescue was absent from all plots.

Table 3

Percentage Occurrence of Individual Species and Bare Ground on the Different Plots (August 1952)

Treatment	Bare Ground	Bent	Cocksfoot	Fescue	Ryegrass (original)	Ryegrass (seeded)	Clover
Nil	50.38	0.78	10.3	14.93	7.47	—	3.2
Soil	5.32	0.52	14.40	1.85	19.57	2.39	55.72
3C	22.41	0.26	24.00	—	30.66	22.13	0.26
12C	13.06	—	31.18	0.26	29.08	25.31	—
3C+S	19.59	0.8	18.41	6.7	30.41	25.06	—
12C+S	21.35	0.52	14.66	0.8	19.98	41.86	0.26
3M	30.12	7.46	34.96	3.39	6.79	10.11	—
12M	40.53	18.9	31.48	2.93	2.38	0.58	—
3M+S	9.06	1.32	21.61	1.59	31.46	7.46	19.74
12M+S	9.79	2.19	26.95	1.06	34.93	1.59	16.0

The Second Season A more detailed survey of the species composition of the plots was carried out in August 1952. The results are summarized in Table 3 on p. 588.

A few species of weeds were found, of which *Agrostis* (bent) was the most common, particularly on the M plots, and this grass is accordingly included in the tables. A varying amount of bare ground is also recorded. This lack of cover may be due largely to failure of any plant development at all on parts of the M plots, and the failing vigour of ryegrass on others. Cocksfoot is the dominant grass in some cases. In a few instances side shoots from tufted ryegrass plants had escaped cutting and had quickly seeded (see Col. 7, Table 3). It is also noteworthy that cocksfoot is slowly establishing itself on M plots and it will be interesting to see if this grass can ultimately maintain itself on this sludge. Clover shows its greatest development on S plots. It also contributes about one-fifth of the coverage of the M + S plots. Its almost complete absence from the domestic sludge plots may be attributed to the early severe competition of the ryegrass. The failure of fescue may also be due to the same cause.

Observations on root development are as yet only of a preliminary nature, but spade holes dug in August 1951, showed that the roots of the grass on the deepest domestic sludge plots had penetrated as far as 2 inches into the ash. The roots of M + S plants, however, were confined to the top inch of the industrial sludge plots.

Domestic Sludge gave Better Results The results of two season's observations lead us to conclude that the application of sewage sludge may prove to be an effective expedient for establishing grass on power station fuel waste, and indeed on other derelict areas produced by industrial spoil.

In these trials domestic sludge has proved to be more useful than the industrial product, although it is possible that, by suitable treatment before or during application, industrial sewage could be improved. The causes of its failure are as yet a matter of conjecture. The experiments seem to suggest that germination and root development are retarded by it. When once established however, grass can tolerate industrial sludge, as illustrated in the M + S trials. The industrial sludge under these conditions apparently has some beneficial effect on the ley, since M + S yields are better than those obtained from S plots. The results yielded by the latter, however, are encouraging and serve to show that soil is a useful expedient to alleviate dust and produce grass when sludge is either not available or an economic proposition. In this respect it is again stressed that the soil used in these experiments was of poor quality. Higher yields might be obtained with good soil.

The writers acknowledge with thanks the assistance and advice of all who helped in this work—The B.E.A., Hams Hall, the Tame and Rea Drainage Board, the N.A.A.S. and Birmingham University Research Committee.

THE MINISTRY'S PUBLICATIONS

Since the date of the list published in the December 1952 *issue of* AGRICULTURE (*p.* 441), *the undermentioned publications have been issued.*

MAJOR PUBLICATIONS. Copies are obtainable, at the prices quoted, from the Sales Offices of H.M. Stationery Office or through any bookseller.

Bulletins

No. 38 Sex Linkage in Poultry Breeding (*Revised*) 3s. 0d. (3s. 1½d. by post)

Other Publications

Housing of Small Domestic Livestock in Gardens and Allotments (*New*) 1s. 3d. (1s. 4½d. by post)

LEAFLETS Up to six single copies of Advisory and Animal Health Leaflets may be obtained free on application to the Ministry (Publications), 36 Chester Terrace, Regent's Park, London, N.W.1. Copies beyond this limit must be purchased from a Sales Office of H.M. Stationery Office.

Copies of Fixed Equipment on the Farm Leaflets are available under the same conditions as for Bulletins (see above).

Advisory Leaflets

No. 69 Cabbage Caterpillars (*Revised*)
No. 396 Chick Rearing (*New*)
No. 398 Preparation of Poultry for Market (*New*)
No. 399 Egg Faults and their Elimination (*New*)
No. 400 Cob Nuts and Filberts (*New*)
No. 405 Cultivation of Fodder Beet (*New*)
No. 408 Kale as a Feedingstuff (*Revised*)

Animal Health Leaflets

No. 39 Contagious Diseases of Rabbits (*Revised*)
No. 44 Mange, Worms, Ringworms and Miscellaneous Disorders of Rabbits (*New*)

Fixed Equipment of the Farm Leaflets

No. 19 Soil-Cement Roads (*New*) 9d. (10½d. by post)

FREE ISSUES Obtainable only from the Ministry (Publications), 36 Chester Terrace, Regent's Park, London, N.W.1.

Growmore Leaflets

No. 1 Vegetables in your Garden and Allotment (*Revised*) (Superseding Dig for Victory Leaflet No. 1)
No. 49 Herbage Seed Mixtures : 1953 (*Revised*)
No. 84 Rations for Livestock : Winter Period, Jan.-April 1953 (*Revised*)

Other Leaflets

Farm Machinery : Prevention of Accidents (*Revised*)
Grants for Farm Water Supply Schemes : Welsh Version (*New*)*

* Obtainable only from Welsh Department, "Caerleon", Marine Terrace, Aberystwyth.

"AGRICULTURE" INDEX

The Index to Volume LIX will be issued with the April number.

FARMING AFFAIRS

Floods in the Netherlands Great as the devastation has been on the east coast, the floods in the South-West Netherlands have imposed an infinitely greater tragedy. About 1,400 people have lost their lives and one-sixth of the whole country has been inundated. This is probably the worst disaster of its kind since that which occurred on St. Elizabeth's Day in 1421, when in one night no less than 65 villages were submerged in a single polder and some 10,000 men, women and children were drowned.

The area affected stretches from the mouth of the Schelde, near the Belgian border, to north of the Hague, including the greater part of the islands forming the Province of Zeeland—land wrested from the sea over the past 700 years. The most sorely stricken is the island of Schouwen-Duiveland, nine-tenths submerged, and the neighbouring island of Over-flakkee, 25 miles long and 18 miles wide, now merely a bleak grey lagoon surrounded by earth embankments.

Our deepest sympathy goes out to the people of the Netherlands in their tragic national disaster, but we can be sure that their enterprise and toil will again triumph over the sea and in the fullness of time recapture these lost acres and bring them back to fertility. The sea may overwhelm the land, but we have had proof in the past that it cannot overwhelm the indomitable spirit of the people who farm in the Low Countries.

In the April issue of AGRICULTURE we hope to publish a first-hand account of the immediate effect of the floods on Dutch agriculture.

Flood Damage to Agricultural Land The Minister of Housing and Local Government announced in the House of Commons on February 19 that farmers will not be asked to pay for gypsum required for rehabilitating flooded land but may have to pay local transport costs from the nearest railway station. The necessary arrangements for providing gypsum will be made as soon as possible, and farmers notified. In the meantime, they are advised not to take any steps in the matter.

The responsibility for seeing that ditches and drains silted up by the floods are cleared will rest on River Boards working in co-operation with internal drainage boards and County Agricultural Executive Committees. The Government will reimburse the full cost of work completed within a month after the sealing of the gaps in the adjacent sea-walls. Farmers who have ploughed grassland under the Ploughing Grants Scheme but have been prevented by the floods from carrying out further operations will be eligible for special payments at the statutory rates.

Farming Cameo : 28. Southern Shrophire The southern district of Shropshire is made up by the 66 parishes of the Clun and Ludlow Rural District Councils, bounded in the south by the Worcester, Hereford and Radnor county boundaries, in the east by the Clee Hills, in the west by Montgomery, and northwards it extends to Church Stretton, 14 miles from Shrewsbury. A country of hills and valleys, this district is one of the most beautiful parts of Britain and is truly pastoral in character.

The western half of the area—once covered by Clun Forest—is bounded on the north by the Longmynd, Stiperstones and the old Bog lead mining area. To the west lie the Kerry Hills. Here, the farming is almost entirely

confined to the rearing of sheep and cattle for sale as stores, although a number of dairy herds have appeared in recent years—some purely for the sale of milk but others where calf rearing is also carried on. Another feature of recent years in this part of the district has been the extent of rough and hill grazings reclaimed and the vigour and skill with which most of the work has been done. The Marginal Production Assistance Scheme and the Hill Farming and Livestock Rearing Acts have had a big influence in this respect.

The eastern half is also engaged predominantly in the rearing of livestock for sale as stores, but near Ludlow lies the Corvedale, considered by many to have the finest bullock-fattening pastures in England. In the Craven Arms–Ludlow area there is also some useful land well suited to arable cropping, while along the Worcester-Hereford boundaries is a fruit- and hop-growing area with Tenbury Wells as its centre. Here, too, dairying has become more widespread in the last decade.

Southern Shropshire is a geologist's paradise. The soils vary tremendously but, except on the heavy red Corvedale land, these do not make cultivations too difficult. Slopes, lack of drainage and climate are more serious obstacles. As in other store stock districts, most fields are deficient in lime and phosphate, and much grassland has still to be improved. Probably the two biggest obstacles to reasonably high production are bad distribution of water (many farms have only one or two drinking places) and inadequate or badly maintained buildings.

Ludlow, the largest town in the area, is also the chief market for store cattle, attracting buyers from many counties. The other main market centre is Craven Arms—the St. Boswells of England—where many thousands of store sheep are sold in the autumn sales. With the recent changes in sheep management, Craven Arms sheep sales have become the Mecca of those buyers from many parts of England who want a good "grass" sheep for feeding, crossing or breeding pure. The local breeds are eminently suited to all these purposes and are becoming increasingly popular.

There are 2,060 holdings in the southern district, comprising a total area of 184,000 acres, of which 24,000 are rough grazings and 2,500 common land. Arable crops account for 37,000 acres, and 26,000 acres are down to temporary leys, mainly clovers. Livestock include 49,500 cattle, 191,500 sheep, 264,000 poultry, 9,250 pigs and 2,200 horses. The Hereford—ideal in many respects for the conditions—together with its crosses, is most common amongst the beef herds, but most other beef breeds are also to be found. Ayrshires and Friesian predominate in the dairying areas, although, again, most of the other breeds, even the Dexter, are represented. Clun, Kerry Hill and Welsh are the chief breeds of sheep. The first two originated in the area and are found generally on the better land. Pure Welsh or Clun-Welsh and Kerry-Welsh crosses are kept on the bleaker upland and hill farms.

Underlying the common policy of livestock rearing in this agriculturally interesting district lie a host of problems which are being tackled in a variety of ways—among them buildings, water supply, labour—although public amenities have improved in the last few years and housing standards have risen. All these have a bearing on the most urgent problem of all—increased economic production.

W. Rollo,
District Advisory Officer

Phosphorous Metabolism The use of phosphate for the stimulation of plant growth, and the need of phosphate, in conjunction with lime, in the diets of young animals for ensuring normal bone development, or. in the case of dairy cows, for making good the losses of these constituents in the milk, are matters of common knowledge to every farmer. Much less familiar, however, is the pre-eminent role that has been assigned to phosphatic compounds in the numerous chemical changes that go on continuously in the body cells and tissues.

The elucidation of the metabolic processes which result in the transformation of chemical energy into the mechanical energy of muscular activity has always constituted a challenge to the biochemist, but it is only during the last quarter of a century that the explanation of these processes has been brought to light. This has served to emphasize the vital importance of phosphate to the animal. Three complex substances, all of them phosphates, are primarily concerned. These are creatine phosphate, adenosine triphosphate (ATP) and adenosine diphosphate (ADP).

It is known that muscle consists largely of a protein called actomyosin, the molecule of which has a thread-like structure and, like the molecule of the protein keratin in wool and hair, is possessed of contractile properties. The total contraction of muscle during activity is the summation of all the contractions of the individual molecules of actomyosin.

The immediate source of energy for muscle contraction is the energy-rich ATP. No other substance can take its place in this capacity. On the arrival of the nerve impulse in the muscle, ATP, by a process known as enzymic hydrolysis, is broken down to ADP and inorganic phosphate. This reaction is accompanied by the liberation of a considerable amount of free energy, and by some process as yet not completely understood, the chemical energy thus liberated is transformed in the muscle fibres into the mechanical energy of contraction and motion. Undoubtedly this reaction involving the breakdown of ATP is one of the most significant of all living reactions.

The organism is able to store up reserves of this so-called "phosphate-bond energy" in the third complex phosphorus compound, creatine phosphate, and this, by interaction with the ADP remaining over from the breakdown of ATP, can regenerate fresh supplies of ATP to function anew as a source of contractile energy.

The ultimate source of all this energy is the glucose derived from the digestion of starch etc., or the glycogen built up in the muscles from such glucose; but the energy coming from the breakdown of glucose or glycogen cannot be utilized for muscular contraction except through the medium of ATP. The oxidative liberation of energy from glucose or glycogen is not a simple reaction, but takes place by means of a series of well-defined intermediate reactions in which phosphate again plays a central role. For example, glucose cannot be oxidized unless it is first converted into glucose phosphate, and similarly, glucose must first be transformed into its phosphate before it can be utilized for the synthesis of glycogen.

Phosphate plays an equally important part in the production of alcohol by the fermentation of glucose by yeast. Indeed, up to a certain point, the reactions involved in fermentation are the same as those in muscle metabolism. At this point, however, under the influence of a yeast enzyme called carboxylase, the current of chemical change in fermentation is turned in the direction of alcohol, whereas in animal tissues, which contain no carboxylase, the reaction proceeds by a circuitous route to the ultimate oxidation products, carbon dioxide and water.

It is the chemical energy associated with the breakdown of ATP which, by transformation into light energy, enables bio-luminescent organisms, such as the fire-fly, to "light their lamps". The electric eel also owes the energy of its electrical discharge to the same source.

It is with problems such as the foregoing that a new publication* from the U.S.A. is concerned. In June 1951 a symposium on phosphorus metabolism was held at the Johns Hopkins University, U.S.A., and this publication contains the papers read at those meetings, together with accounts of the discussions which followed the reading of the papers. The communications cover a very wide field and are presented by acknowledged authorities. The subject-matter is essentially technical and is intended primarily for biochemical students and research workers. To such readers, wishing to gain the most recent information about the role of phosphorus and its compounds in the metabolism of plants and animals, the publication will come as a source of enlightenment and inspiration.

H. E. Woodman

Hedgerow and Farm Timber : Appointment of Committee A good deal of the existing hedgerow timber of Britain is mature or overmature and, in consequence, a considerable amount is being licensed for felling every year. The Forestry Commissioners are naturally anxious that timber cut from hedgerows and on farms should be replaced and, accordingly, the Minister of Agriculture and the Secretary of State for Scotland have appointed a Committee to " examine the extent to which the growth of hedgerow timber is compatible with good agricultural practice ; and to make recommendations as to the best means of securing the planting and tending of hedgerow timber ". The members of the committee are Lord Merthyr (Chairman), The Earl of Haddington, Mr. F. G. Chalke, Mr. N. D. G. James, Mr. J. Wallace Mann, Mr. A. D. C. Le Sueur, and Mr. G. T. Williams. Representatives of the Ministry of Agriculture, the Department of Agriculture for Scotland, the Ministry of Housing and Local Government, the Ministry of Transport and the Forestry Commission will attend the meetings as assessors.

The Committee invites interested persons and bodies to communicate with the Secretary without delay. Papers are required not later than May 1, 1953. The Secretary to the Committee is Mr. T. Farmer, Forestry Commission, 25 Savile Row, London, W.1.

The World's Dairy Herd The task which faced the dairy industry in 1945 of building up the world's dairy herd to its pre-war size was indeed formidable. Slowly, however, numbers increased, until in early 1951 it was estimated that the target had been reached. Unfortunately, in several Commonwealth and Continental countries, as well as in North America, a decline was setting in and, by the end of 1951, numbers were again below those of 1938. It was this falling-off, combined with the cold spring weather in Europe and North America, and a severe drought in Australia, which led to the marked decline in world milk production in 1951. On the other hand, the higher yields per cow now being obtained have raised total output of liquid milk to slightly above the 1938 figure.†

**Phosphorus Metabolism.* Vol. 1. Edited by William D. McElroy and Bentley Glass. Oxford University Press. 80s.

† In the United Kingdom, the average milk yield per cow in 1951 was 590 gallons, compared with 542 gallons in 1938.

Nowadays, with an ever-increasing expansion in the consumption of liquid milk in certain producing countries, any fall in milk production is, for the most part, reflected in lower supplies for manufacture. And, since the production of cheese and preserved milk generally increased in 1951, the main weight of this particular cut fell upon *butter*. Thus the world butter production which, in 1950, had been only 11 per cent short of the 1938 level, declined sharply to about 85 per cent of pre-war. Because of rising consumption in exporting countries, world exports of butter fell to 70 per cent of the pre-war total. The most serious fall of all occurred in Australia, where exports in the 1951–52 season amounted to little more than 10,000 tons, against 55,000 tons in 1950–51 and 100,000 tons in 1938.

The effects of these changes on United Kingdom imports were drastic and, with home production also dropping sharply in 1951 to one-third of the level of the previous year and not much more than one-quarter of the 1938 figure, the amount of butter consumed per head in this country in 1951 (15 lb.) was 2 lb. less than in 1950 and about 10 lb. less than in 1938. Prices also rose, so that it is perhaps not surprising to find that the consumption of *margarine* per head in the United Kingdom reached the record figure of 18 lb. in 1951. The figures available for 1952 show that the trend towards lower milk and butter production continued in Continental Europe, but the prospects in New Zealand (the largest exporter of butter and cheese), Australia and Canada were much more encouraging.

World production of *cheese* in 1951 was about 30 per cent above the pre-war level, and little change was evident in 1952. The international trade is also much larger than before the war, due partly to increased supplies from New Zealand and Australia, but to a greater extent to the expansion of exports of fancy cheeses from Europe. In consequence, it is estimated that the consumption per head in this country in 1951 was 10.3 lb., compared with less than 9 lb. before the war, although the amount of home-produced cheese was little different.

The number of hens and total *egg* production in Western European countries—traditionally the main sources of eggs—increased steadily up to 1950, but dropped sharply in 1951. Little change was evident in 1952. Imports into the United Kingdom in 1951 were one-third less than in 1950 and less than half those in 1938. This decline, however, has been offset by greater home production, with the result that consumption per head in 1951 was estimated to be little short of the pre-war level ; allocations for the ration amounted to 102 eggs per head in 1951, and were about the same in 1952.

These facts and many others concerning the production, consumption, and international trade in dairy produce during 1950 and 1951, are included in the new Commonwealth Economic Committee's review* of the dairying industry of the world. The review also deals with preserved milk as, for example, *condensed milk* and *milk powder*. In both these products, the output is much greater in most countries than it was before the war, while, in the case of *evaporated milk* (unsweetened condensed), exports rose considerably in 1951. Most of it came from the U.S.A. The share of the Commonwealth countries in the condensed milk trade is not large, but they are providing an increasing amount of milk powder, and a high percentage of that entering the United Kingdom is of Commonwealth origin.

* *Dairy Produce*. Obtainable from H.M. Stationery Office, through any bookseller, or from The Secretary, Commonwealth Economic Committee, 2 Queen Anne's Gate Buildings, Dartmouth Street, London, S.W.1, price 5s. (5s. 3d. by post).

Krilium In December 1951, publicity was given to the discovery of a new way of improving soil structure by the use of certain synthetic polyelectrolytes produced by Monsanto Chemicals Ltd. under the trade name Krilium. Other conditioners were subsequently announced by other manufacturers.

During 1952 experiments have been made with Krilium by several Agricultural Research Institutes in this country (including Rothamsted, Long Ashton, the John Innes Horticultural Institution, the Experimental and Research Station, Cheshunt, and the National Vegetable Research Station) and by the National Agricultural Advisory Service. The substance used was supplied by Monsanto Chemicals Ltd. as Krilium (CRD. 189) and described as a sodium salt of polyacrylic acid. This was the earliest available soil conditioner and in its original form proved rather difficult to incorporate in moist British soils.

The Agricultural Research Council reports that the results of the 1952 experiments have now been examined ; they were not expected to be more than preliminary because there are still many questions to be answered. For example, it is particularly necessary to know how long the effect of soil conditioners persists in the soil. No definite conclusions, therefore, can be drawn at this stage of investigation.

In view of the current interest in the subject, however, the initial findings can be summarized as follows : (1) improvement in structure after treatment was apparent in many of the soils tested ; (2) the uptake by plants of major and minor nutrients was not adversely affected ; (3) the activity of soil micro-organisms was normal ; (4) no conclusive evidence was obtained that the application of Krilium caused any significant increases in crop yields of field or of glasshouse crops, though in certain cases increased yields were recorded. Much more experimental evidence on the best method of incorporation, degree of aggregation and persistence of structure of treated soils, and the relation of these to crop yields is required before any definite conclusion can be reached.

Towards the end of the year Monsanto Chemicals Ltd. made available a new soil conditioner, described as a calcium salt of vinyl acetate—maleic acid copolymer. This was found to be more easily incorporated in soil and is stated to have better soil aggregating properties than CRD. 189.

Experiments will be continued in 1953 and the results, when complete, will be made available for publication.

BOOK REVIEWS

Community Farm. J. MIDDLETON MURRY. Peter Nevill. 16s.

Community Farm is not written primarily for agriculturists. It is the story of a farming enterprise based on the author's belief that community life on the land is the best way to get more people back into agriculture. The author tells how during the war he gathered together a group of pacifists of mixed sincerity to run a farm on community lines. His own faith in the enterprise is shown by the fact that he shouldered the financial responsibility for the experiment. In due course the farm prospered, though, one feels, by an unnecessarily tortuous process, and what was once a derelict C farm is finally graded A. The author's impartiality—an outstanding feature of the book—might have allowed him to take a little more of the credit to himself. In the process, Mr. Murry's views on community life also undergo a change.

There is a compelling candour and sincerity about the book. Mr. Murry's approach to people and theories is always objective. Mistakes are described as faithfully as successes;

but mixed with the serious business of farming, it becomes apparent that theories must await a more idealistic human element to carry them through. The comings and goings of a succession of social misfits who find temporary shelter at "Community Farm" are described with a generous sympathy.

The author deviates from his main theme from time to time to give the reader some keen and impartial analyses of people and events, and his observations on village life show an understanding and appreciation of country folk.

T.W.

Sugar Beet Diseases in Ireland. ROBERT MCKAY. Colm O. Lochlainn. 21s.

Most of the countries which grow sugar beet sooner or later issue a publication dealing with the diseases of the crop. This inevitably leads to repetition of much of the information in them but they are justified because the varying conditions of climate, cultivation and agricultural organization result in the various troubles acquiring a different importance and therefore needing greater or less emphasis. Professor McKay, with the encouragement of the Irish Sugar Company, has produced this monograph for Irish farmers and advisory officers.

A full account is given of seedling diseases, which have resulted in much loss in Ireland, especially Black Leg caused by *Phoma betae*. Many of the other troubles described are at present more of academic than practical interest, but may quickly become of economic significance with changes in cultural practice. This has occurred in Ireland, as indeed in most other countries, with Downy Mildew and Virus Yellows, when sugar beet and mangold seed production has been undertaken along with growing the root crop. It is interesting to read of the measures which have been taken to reduce Virus Yellows in Ireland, but in view of the great importance of this disease throughout Western Europe a fuller account of what has been done and the results achieved would have been welcomed. It is useful to have a short description of *Ramularia* Leaf Spot, which has caused some concern in Ireland and might flare up anywhere in a cold, wet summer ; more experimental work on it is obviously needed.

The information in the book is largely built up from scientific publications, to which selected references are given. In some chapters, for instance that on Violet Root Rot, undue emphasis has been given to the early academic and taxonomic work at the expense of more recent researches on incidence and control, which would have been more appropriately included in a book of this type. The publication is very attractively produced and is well illustrated with excellent plates, some of which are in colour.

R.H.

Highlands of Scotland (County Book Series). SETON GORDON. Robert Hale. 18s.

The County Books series published by Robert Hale Ltd. is of established reputation. That a volume is included in the series is a sufficient guarantee of its production and illustration. Choice of the most suitable author for each volume is obviously a more difficult task. For instance, while John R. Allan has dealt recently with the North-Eastern Lowlands of Scotland, Seton Gordon was invited to write of the Highland Mainland. The outlook, style, temperament and method of approach of these two authors is as different as chalk is from cheese. John R. Allan is of this generation, Seton Gordon of the last, and it may well be asked why, if someone as modern-minded as John R. Allan was invited to guide us to one section of Scotland, anyone so delightfully old-fashioned as Seton Gordon was selected as guide to the other.

Seton Gordon's approach to the Highlands is, of course, out-dated and nostalgic, as he most probably would be the first to admit. The Highlands of which he writes—and how charmingly he writes of them—have been slowly dying for two centuries. The language, the dress, the music, the ethics, the good breeding of the true Highlander are all in palpable, if pathetic, decay. Indeed once all those who were "out" in the Highlands in 1745 went in again, nothing very much beyond sentiment and relics has ever emerged from that region. It didn't particularly matter in Victorian and Edwardian days, when the vulgarity of a plutocracy very much alive found a saving grace in mingling with the better bred ghosts of an aristocratic tradition. But now that plutocracy in Britain is following aristocracy to its grave, is there any real value or reason in perpetuating the old sadistic legends of clan atrocities ; the prayers for the restoration of the Stuarts, the osprey and sea-eagle ? More, possibly far more, than meets the strictly material eye. It is romance and nothing else than romance that brings tourists in their thousands from all over the world to see the Scottish Highlands in their season—a point that the economists might well ponder.

A.F.

Trace Elements in Plants and Animals (2nd Edition). WALTER STILES. Cambridge University Press. 15s.

Although this book is labelled " Second Edition," it would be more correctly described as " reprinted with minor amendments and additions ", as is indeed indicated in the author's preface to the book. It differs from the first edition only by a few minor amendments and the addition of one plate and fourteen supplementary references.

It is evident that no attempt has been made to make a thorough overhaul of the text and to bring it right up to date, and since the revision appears to have been made in 1948, only four years after the writing of the first text (which was published in 1946), the author no doubt considered it premature to do so.

Perhaps the lag in publication is responsible for statements remaining in the text (on pages 56, 68 and 90) that no cases of deficiencies of molybdenum, zinc and copper respectively have so far been recognized in Britain.

The erroneous statement beginning at the bottom of page 131—that teart soils occur only on drift-free soils on the Lower Lias—remains uncorrected (e.g., Hambridge Series Soils—Table XVIII—are derived from drift deposits). In this table "type" should read "series".

Investigations of trace element problems in both plants and animals continue to attract much attention in many countries, and in the course of the next two or three years it is to be hoped that a further revision of this book will be made to record the new information gained. When this is done, a thorough overhaul of the illustrations should also be undertaken; the text of a book of this type cannot be said to be adequately illustrated by fourteen plates, of which four relate to manganese deficiency, seven to boron deficiency, and one each to copper and molybdenum deficiencies, the animal section being entirely without any illustration.

Meanwhile this second edition should continue to serve the useful function of its predecessor.

T.W.

The Farmers Tools. 1500-1900. G. E. FUSSELL. Andrew Melrose. 42s.

The historian has three main jobs : to tell what happened, to explain why it happened, and to show what mattered. In *The Farmers Tools* Mr. Fussell has limited himself to the first of these purposes. We find little in his pages on either the causes of technical development or the relative importance of different inventions and their effects on rural economy. His book, therefore, is a catalogue rather than a history. But it is a useful catalogue, the first of its kind in this country, and it comes as a welcome addition to the pitifully small library which describes the industrial history of British farming.

Mr. Fussell deals with his subject systematically. He begins with the tools and equipment used in field drainage, and then works his way through the farming year, from the preparation of the seedbed, via sowing and harvesting, to threshing. In each case he describes in chronological order the development of the particular tools used by the farmer in each particular job. Thus the chapter on threshing the grain first mentions the flail and then traces mechanical threshing from the water-driven flails of Menzies to the familiar machines built at the end of the Victorian age. The book concludes with a unique chronology of the farmer's tools, and a bibliography. The illustrations, which number over a hundred, deserve special praise, and add greatly to our understanding of matters which are peculiarly difficult to describe in words. Mr. Fussell has earned well of the student of agricultural history by making available a mass of information never before collected between two covers.

Unfortunately, however, the value of this book is greatly reduced by a curious lack of precision and "finish". There are too many omissions for historical comfort. Thus we are told that wire rope was a prerequisite of effective steam cultivation, but nowhere are we told when or by whom this was invented. Again, if Mr. Fussell can stretch his terms of reference to include Chinese seed drills of 2800 B.C., he could surely find space for that landmark in agricultural history, the date when the last steam-ploughing tackle was manufactured in this country. Similarly, it seems probable that Hawkins became, in 1812, the first man ever to thresh corn by steam power. He used one of Trevethick's engines but neither the landowner nor the engineer appears in the index of this book. And why, when the records of the Patent Office are available, should we be content with the second-hand statement of Ransome that Salmon's tedder was patented in 1816 ? Then, too, it is misleading to start the milking machine story in 1862, when two vacuum-type plants were patented before that date. Indeed, the chapter on barn machinery is particularly inadequate, and the bibliography makes no mention of the books of Loudon (on farm buildings),

and Dean and Denton, who describes the achievements of the nineteenth century in mechanizing of the operations of the farmstead. Minor points ?—possibly, but history is composed of minor points, and before a book can be esteemed faithful and thorough in great things, it must first be faithful and thorough in small.

N.H.

Potash : Its Production and Place in Crop Nutrition. G. A. COWIE. Edward Arnold. 21s

Although potash was tested from 1843 onwards in the Rothamsted experiments, and was shown to have definite value for certain crops and soils in the late 1860s, the agricultural demand for potassic fertilizers grew extremely slowly. The reason for this was that in the prevailing system of farming based on grain and livestock the drain on the soil reserves of potash was comparatively low. Under this system it was NP rather than NPK. The picture changed completely with the development of intensive potato growing, and the introduction of sugar beet. The big expansion of market gardening and fruit production, coupled with a reduced supply of stable manure, further stimulated the demand for potash.

In his book Dr. Cowie has collected much information about potash that students, farmers and their technical advisers would find it difficult to assemble for themselves. The book is primarily written from the agronomic angle, and rightly so. Those who want to study the geological or chemical aspects of the potash deposits have specialist literature to draw on ; nevertheless, agricultural readers will find in this book sufficient up-to-date information in regard to the occurrence and refining of the deposits to provide the necessary background. There is an interesting chapter on potential sources of potash (including the recently discovered deposits in N.E. Yorkshire) as distinct from those already developed in many parts of the world. Dr. Cowie also deals with the various minerals and by-products that have from time to time been worked as sources of agricultural potash ; but few of them can compete with the cheaper processes based on the salt beds. Among these alternatives, dung occupies a special place—in this country, before the war, two-thirds of all the potash reaching the land was applied as farmyard manure.

The relationship of potash to soils and crops is the subject of a lengthy chapter, in which such practical matters as the aggravation of potash deficiency by phosphate and nitrogen, and of magnesium deficiency by high potash content, are discussed. Potash manuring should, of course, be considered in relation to the soil status and the other nutrients, and this point is illustrated in the second half of the book by a summary of the manurial treatment of farm, fruit and market-garden crops in this country, and of a number of plantation crops in the Commonwealth. For each crop the main conclusions in regard to potash manuring as part of the general scheme of fertilizer treatment are set out, and results of modern experiments are quoted wherever possible. There is still ample scope, however, for the extension of field experiments to survey a much wider range of soil types and climatic conditions.

The book contains much useful statistical and other data which have hitherto been widely dispersed, and gives references to the more important papers on the subject.

H.V.G.

Herdsmanship. NEWMAN TURNER. Faber. 18s.

The author of this book learnt his herdmanship in the hard and sound way—by practical experience. Milking his first cow at the early age of five years, and no doubt progressing by trial and error, he built up a successful and well-known pedigree herd. There is a great deal of common sense in the pages dealing with breeding, rearing and judging : the reasons for requiring the generally-accepted conformation points of the dairy cow are carefully thought out and clearly expressed. For instance, his forthright condemnation of sickle hocks and insistence of the value of good legs in a dairy cow will be endorsed by all competent breeders. The chapter on practical breeding and simple genetics will be of interest and value to the beginner. Decided views are also expressed on the need for revising conditions and standards for pedigree sales, with the laudable idea of creating the confidence of purchasers.

Manuring exclusively by natural means and feeding his cattle mainly on organically-grown food and herbs, the author claims to have brought his farm to a state of health and abundance. Diseases of animals are perhaps dealt with in a somewhat light-hearted manner, and the claim that foot-and-mouth disease is no more than a bovine form of influenza with negligible after-effects cannot be accepted seriously.

The appendices contain articles by well-known contributors on the various dairy breeds and are full of interest. Useful information is also given on such things as the composition of milk, the estimation of the contents of stacks, silos, etc.

Finally, cattlemen will find in this book much to stimulate thought ; the numerous photographs, too, are not merely decorative, they really illustrate the text.

H.L.S.

Marketing (Young Farmers' Club Booklet No. 26). IAN G. REID. Evans Bros. 2s.

Side by side with the problem of increased agricultural production in this country lies the problem of efficient marketing. But whereas on the production side the way is almost as clear as the need, in marketing there is often a great conflict of opinion. Some people would leave things to the competitive element in supply and demand, others favour Marketing Boards, while others again see salvation in cutting out the middleman or at least drastically reducing his profits. This booklet wisely avoids any such arguments. It first presents the problem of marketing in simple terms of " Time, Place and Form ", and then goes on to show the very wide differences that exist as between one product and another and the equally wide differences in the methods that have been adopted to improve efficiency in each case.

Under "Time", Mr. Reid includes not only the period necessary to get produce from producer to consumer but also the storage of seasonal production until it is wanted or can be processed (e.g., potatoes, sugar beet). "Place" involves a consideration of the distance and the channels that must be traversed between producer and consumer. "Form" covers all these changes that are necessary to convert primary products into the form required by a consumer (e.g., wheat into bread). To illustrate (and he does not claim to do more than this) the wide variations in this threefold problem, Mr. Reid takes eight agricultural products—milk, eggs, beef, wool, wheat, potatoes, Brussels sprouts and sugar beet—and describes existing methods of marketing each of them and the progress that has been made during the past twenty-five years. This takes him to the operations of the pre-war National Marketing Schemes and Marketing Boards set up under the Agricultural Marketing Acts for milk, potatoes and wool, as well as the Ministry of Food controls.

Apart from a brief reference to new potatoes and a short chapter on Brussels sprouts in which he traces the produce from farm to retailer, Mr. Reid steers clear of the vexed problem of horticultural marketing. In his conclusion he refers to the " price spread " between producer and consumer in terms of his original formula, " Time, Place and Form ". Finally, he comments on the steady progress that has been made in the development of grading and packing.

As an introduction to agricultural marketing problems, the booklet is to be commended. The eight products he has chosen enable the author to illustrate his choice adequately and he makes it clear that in the space at his disposal he can do no more than this. What he has written will make his young readers want to know more and, as Mr. Reid says, his booklet may give them ideas on how to set about it.

G.S.B.

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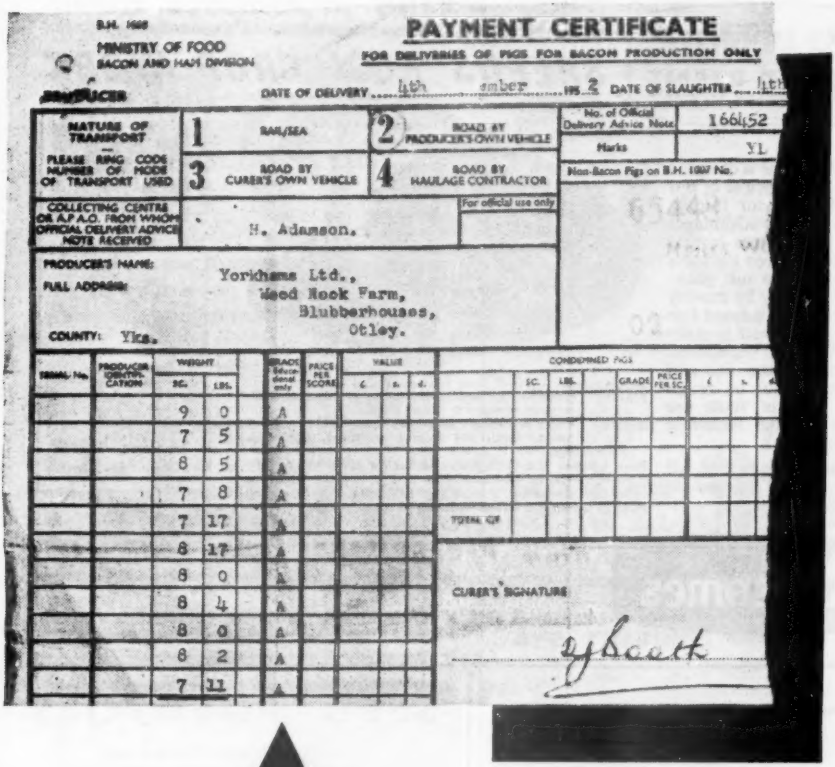

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